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OF THE

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OF THE

LEGISLATURE OF THE STATE OF CALIFORNIA.

Volume IV.

SACRAMENTO:
STATE OFFICE . . . . . . JAMES J. AYERS, SUPT. STATE PRINTING.
1885.

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CALIFORNIA STATE MINING BUREAU.

THIRD ANNUAL REPORT

OF THE

STATE MINERALOGIST

FOR THE YEAR ENDING JUNE 1, 1883.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1883.

To his Excellency George Stoneman, *Governor of California:*

Sir: I have the honor herewith to submit to you the third annual report of the State Mineralogist of California, in compliance with section three of an Act of the Legislature, entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880.

I have the honor to be, very respectfully,

HENRY G. HANKS,
State Mineralogist.

San Francisco, June 1, 1883.

REPORT OF THE STATE MINERALOGIST.

The California State Mining Bureau was created by an Act of the twenty-third Legislature, approved April 16, 1880. The first section of the Act provides for a principal office in the City of San Francisco "in which there shall be collected and preserved for study and reference all the geological and mineralogical substances—including mineral waters—found in the State." The same section further provides for a collection of minerals, rocks, and fossils of other States, Territories, and countries, to be at all reasonable hours open for public inspection, examination, and study.

Section three provides for a library of works on mineralogy, geology, and mining, a collection of models and drawings of mining and milling machinery used in the reduction of ores, and directs the opening of correspondence to obtain information respecting improvements in mining machinery of practical value to the people of the State. The State Mineralogist is instructed to visit the several mining districts, to ascertain and record their history, and to describe their geology and the ores they produce. At the close of the year he is directed to report in detail to the Governor. By section four the State Mineralogist is allowed to appoint assistants when the condition of the funds will permit. All other provisions are secondary and subservient to the Museum, which is made the principal feature of the institution.

The full text of the Mining Bureau Act was published in the first report of the State Mineralogist, December 1, 1880.

Since the second and last report, October 1, 1882, a fair progress may be reported.

The Mining Bureau still occupies the premises No. 212 Sutter Street. Important and valuable additions have been made to the Museum, a considerable portion of which have been catalogued and placed in the cases. The actual number of Museum specimens entered since the last report, is 1,065, and the total number in the catalogue, 5,212. There is as yet no catalogue of the books, of which many have been received during the year.

The following is a list of names of donors, whose contributions have been entered in the catalogue. Others will be published in the next report. Some of the donors have made a number of gifts, although the name appears but once in the list. When the new catalogue is published full credit will be given for each specimen presented. The donations to the Museum and Library have been of unusual interest, and many of them of great value.

LIST OF DONORS.

Abbott, Henry,
Alderman, E. M.,
Aldrich, H. A.,
Alexander, A. M.,
Allen, C. F.,
Amick, M. J.,
Attwood, Melville,
Ayres, William,
American Museum of Natural History.

Ballarat School of Mines,
Balser, George,
Barnard, John Kirk,
Barnes, Edward,
Basse, Louis,
Bassett, William D.,
Battursby, Captain,
Beardsley, George F.,
Behrens, James,
Bilty, Theodore G.,
Bluxome, Isaac,
Booth, Edward,
Borden, R. V.,
Boyd, Mrs.,
Briggs, Rev. Mr.,
Brown, Charles W.,
Brown, William, Jr.,
Brumagim, J. W.,
Buckingham, N. D.,
Burchard, Horatio C.,
Burke, Morris,
Bush, Mrs. A. E.,
Buswell, Alexander,
Butler, J. H.

Cain, J. W.,
Caldwell, H. M.,
California State Geological Society,
Carmany, J. H.,
Casanueva, F.,
Casarello, J.,
Cherry, William,
Cincinnati Society of Natural History,
Clark & Son,
Clarke, William,
Classen, J. M.,
Cohen, Richard,
Cole, A. M.,
Colerick, J. K.,
Collins, S. W.,
Comstock, Charles H.,
Connelly, T. F. A.,
Cooledge, C. C.,
Cook, Prof. George H.,
Cooke, J.,
Cooper, Ellwood,
Cresswell, John,
Cresswell, Mrs. John,
Crossman, J. H.,
Culver, J. H.,
Currie, William.

Daggett, Hon. John,
Dana, A. W.,
Daunet, L.,
Davenport Academy of Sciences,
Davies, P.,
Davis, J. Z.,
Day, Mrs. H. H.,
DeBegon, L.,
Decker, Peter,
DeGoha, A. W.,
Department of the Interior, U.S.,
Donough, T.,
Donnelly, Dr. E.,
Dorman, Levi,
Drake, Frank,
Dunn, R. L.,
Durden, H. S.

Edman, J. A.,
Eger, Dr. L.,
Eleau, H.,
Elliott, Andrew,
Ellis, John E.,
Elwyn, F.,
Emersley, J. D.,
Emerson, George W.,
Everett, T. B.,
Ewing, Thomas.

Farrington & Moss,
Faulhaber, Carlos,
Fay, Caleb T.,
Febiger, C.,
Figel, Philip I.,
Figg, E. P.,
Figuera, L.,
Folingsby, T. H.,
Fracker, A. H.,
Friend, Charles W.,
Frost, C. W.

Galbreath, R. H.,
Gallagher, Edward A. T.,
Gallagher, Frank,
Gascoyne, W. J.,
Gates, Harry,
George, Arthur T.,
George, Dr. S. G.,
Gilmore, Thomas,
Gladding, McBean & Co.,
Glass, Louis,
Gorley, Captain H. A.,
Gould, James,
Graham, J. M.,
Green, H.,
Green, J. C.,
Griffin, J. B.,
Griffin, Thomas,
Grigsby, R. F.,
Gutzkow, Fr.

Haggin, J. B.,
Haher, E. C.,
Hain, E.,
Hanks, H. G.,
Hartley, H. H.,
Hartson, Hon. C.,
Harvey, Dr. Philip,
Hawes, G. H.,
Hawkshurst, H.,
Hazen, General William B.,
Heald, E. P.,
Hearn, Dr. F. G.,
Heverin, M.,
Heydenfeldt, S., Jr.,
Hittell, John S.,
Hoitt, J. S.,
Holcombe, S. E.,
Holmes, A. J.,
Holt, W. H.,
Howe, H. M.,
Hughes, Dr. C. B.,
Hulford, E. W.,
Hunter, Thomas G.,
Hyde, H. C.

Johnson, J. F.,
Jones, Dr. William.

Kaufman, Charles,
Keeler, Hon. J. M.,
Keeney, G. D.,
Keep, Col. Albert,
Keep, Mrs. A.,
Kennedy, Ed.,
Kimble, George W.,
Knapp, C. R.,
Knox & Osborn.

Landis, John,
Lawton, W. S.,
Leary, John,
Linton, W. D.,
Liversidge, Prof. A.,
Lombard, J. W.,
Loomis, J. W.

MacKillican, D. R.,
Manning, J. G.,
Manter, J. R.,
Marcou, Jules,
Marcus, Morris,
Marriotte, Noel,
Martin, E. W.,
Martin, G. W.,
Mason, W. B.,
May, Henry,
Maynard, H. G.,
McDougal, W. C.,
McGrew, William K.,
Mercantile Library Association,
Merrill, F. H.,
Minister of Mines, B. C.,
Mintzer, William H.,
Monteverde, F. E.,
Montgomery, Zach.,
Moody, W. H.,
Moraga, J. C.,
Morales, A.,
Morgan, D. W. C.,
Moss, Joshua,
Munroe, Prof. Charles E.,
Murdock, W. B.,
Murray, Welwood.

Nichols, George.

Oakland Gold Mining Company,
Ogg, C.,
Oregon Iron Company,
Osborn, H. E.,
Osborn, Joseph.

Parker, James E.,
Paul, A. B.,
Peck, W. H.,
Perkins, Henry C.,
Peticolas, C. L.,
Philips, George K.,
Pilsbury, Charles J.,
Porter, W. H.,
Pownall, J. B.,
Price, Col. E. H.,
Price, Edward M.,
Putnam, Mr.

Quayle, William.

Ramsey, Prof. Alexander,
Randall, William H.,
Randol, J. B.,
Raymond, W. H.,
Rhodes, John,
Roberts, A. E.,
Roberts, E. W.,
Robinson, William,
Rosecrans, General,
Rowley, A. B.,
Russell, B. D.,
Russell, D.,
Ryan, J. F.
Sarvis, George C.,
Schaeffle, E. H.,
Scott, Chalmers,
Scupham & Childs,
Scupham, J. R.,
Sellers, Charles,
Sheerer, Joseph,
Shepard, Prof. C. W.,
Silver, Lowry,
Sime, William K.,
Skellings, E. M.,
Skinner, M.,
Sletcher, F.,
Smith Bros.,
Smith, F. W.,
Stanley, W. H.,
Stearns, Robert E. C.,
Stokes, W. C.,
Stone, Charles S.,
Stone, Dudley C.,
Stout, Dr. A. B.,
Stoutenborough, J. H.,
Szabo, Dr. Joseph.

Taglebue, Frank,
Tanner, Mrs. J. G.,
Thomas, R. P.,
Toomey, M.,
Townsend, Mrs.,
Truett, M. F.,
Tryel, Mr.,
Tyler, Charles M.

Union Pacific Salt Company.

Walkinshaw, Robert,
Ward, H. H.,
Ward, W. E.,
Wasson, Hon. Joseph,
Waterman, J. S.,
Weir, J. C.,
White, D. Morgan,
White, Mrs. J. S.,
Williams, Albert, Jr.,
Williams, Blanchard & Co.,
Williams, Col. A. F.,
Williamson, Col. R. S.,
Wilson, George R.,
Wilson, J. F.,
Wilson, W. H.,
Winterburn,
Woodhull, S. D.,
Woodley, W. J.,
Worcester Royal Porcel'n W'ks,
Wynant, N.
Young, W. W.

The following newspapers have been sent to the Mining Bureau gratuitously:

1. Engineering and Mining Journal, New York.
2. Mining Record, New York.
3. Mining Review, Chicago, Illinois.
4. Economist, Boston, Massachusetts.
5. Daily Report, San Francisco.
6. Daily Transcript, Nevada City, Nevada County, California.
7. Grass Valley Union, Nevada County.
8. Sierra County Tribune.
9. Democratic Standard, Eureka, Humboldt County, California.
10. Inyo Independent, Inyo County.
11. Reno Evening Gazette, Reno, Nevada.
12. Arizona Gazette, Phœnix, Arizona.

LIBRARY.

The increase of the library has been principally by donation—a few indispensable volumes only have been purchased. The library of the State Mining Bureau should contain all standard scientific works and books of reference, specially those bearing on mining, metallurgy, chemistry, mineralogy, geology, paleontology, etc., and publications of scientific societies at home and abroad. These works should always be accessible to those who wish to study, but never be taken from the rooms.

PUBLICATIONS.

The State Mining Bureau has made two reports, and published the First Annual Catalogue of the State Museum. For reasons set forth, they were not issued at regular intervals, but are equivalent to annual reports. The dates of the publications are as follows:

First Report, from June 1 to December 1, 1880; forty-three pages.

Second Report, from December 1, 1880, to October 1, 1882; five hundred and fourteen pages.

First Annual Catalogue of the State Museum of California, for the year ending April 16, 1881; three hundred and fifty pages.

Of the first report a second edition was ordered printed by joint resolution of the Legislature. Both editions of the First and the whole of the Second Report have been distributed; a few copies of the Catalogue remain.

Owing to inexperience and want of proper assistance, the Second Report was defective in being without an index, which has been as far as possible remedied by the printing of an index and a correction sheet, which will be furnished to those having copies of the report, upon application. A few copies of the Second Report were reserved until photographs showing the modes of hydraulic mining in California could be prepared. Copies of the illustrated report have been sent to the Secretary of State of every State and Territory in the Union and to the principal Governments of the world.

With this, the Third Annual Report, a second part has been prepared, entitled:

"A Report of the Borax Deposits of California and Nevada, giving the Production, Consumption, Uses, History, Chemistry, and Mineralogy of Boracic Acid and its Compounds, and other General Information, with a Map showing the Principal Localities in the Two States," which is the sixth of a series of papers on the principal natural products of California; *Hydraulic Mining*, *Forest Trees*, *Diatomaceous Earths*, *Diamonds*, and *Salt* having been specially treated in the Second Report.

LABORATORY WORK.

The importance of complete analyses of ores, minerals, mineral waters, building stones, rocks, limestones, cements, fertilizers, etc., laboratory experiments bearing on the working of complex ores, and a careful study of low grade ores, and those requiring concentration, is fully realized by the State Mineralogist; and a course of such work was early planned, the results of which it was hoped would form an interesting and important part of the annual reports.

But, owing to the forced closing of the laboratory and discharge of the Chemist, there is but little chemical work to report. Many examinations of minerals have been made by the State Mineralogist personally, and information sent to those asking it, but this class of work has not been done to the extent it should be, for reasons set forth in this and preceding reports. A number of analyses of coal from newly discovered localities, and of ores and minerals, in a few cases, have been made; but the meager results have been reserved for future publication. The results of considerable study of the borax minerals of the State appear in Part Second of this report.

FINANCIAL CONDITION OF THE MINING BUREAU.

CALIFORNIA STATE MINING BUREAU.

Receipts and Expenditures from September 1, 1882, to June 1, 1883.

Postage	$43 85	Mining Bureau fund	$1,882 20
Museum expense	8 55	Wells, Fargo & Co. advances	1,205 05
General expense	2,190 70		
Maps	7 00		
Salaries	733 70		
Library	9 00		
Traveling expense	63 90		
Cash on hand	30 55		
Total	$3,087 25	Total	$3,087 25

Amount paid into Mining Bureau Fund and retained by State Treasurer pending the Auditing of Accounts of Mining Bureau.

April, 1883	$522 65

Expenses incurred, but not paid, from September 1, 1882, to June 1, 1883.

General expense	$484 80
Salaries	600 00
Total	$1,084 80

The books of the Mining Bureau show a deficiency of $3,864 for the three years, which has been advanced from time to time by Wells, Fargo & Co. For this there are vouchers, showing that the amount has been economically expended. These vouchers have been examined by the State Board and found correct, but have not been allowed, because the law provides that the expenditures shall not exceed in any year the income for that year, but no provision was made in the law to meet the emergency caused by the rapid diminution of the fund. Every economy has been practiced to make the expenses as small as possible without actually closing the Museum, which the law directs shall be kept open. Messrs. Wells, Fargo & Co. have not only advanced money to the institution, but have delivered a multitude of packages free, and have extended many favors for which the State owes them a debt of gratitude.

When the Mining Bureau first commenced operations the fund for its support was ample. During the next twenty-two months, up to the publication of the Second Report, the income gradually diminished until the last quarter, during which it fell to the monthly average of $542 66, upon which it was impossible to support the institution. The deficiency was made up, as before stated, by advances by Wells, Fargo & Co., without which the institution would have been compelled to close its doors at a time when its usefulness and importance were admitted, not only by the citizens of our own State, but by those of Eastern States and foreign countries.

It then became apparent that it was a mistake to appropriate an uncertain sum for the support of a noble State institution; it would have been much better to set aside a fixed amount, even if it had been smaller, and to have allowed the tax transfer fund to revert again to the State Treasury. The latter, however, being the only support of the institution, great inconvenience followed its diminution.

By dispensing with the services of a Secretary, and for a time with those of a Janitor, it was planned to return to Wells, Fargo & Co. the advances made by them, from the savings. But the decision of the Board of Examiners made this impossible. There is no doubt in my mind that the next Legislature will provide for the deficiency by a special Act.

The Legislature of 1881 was asked to make some provision for the Mining Bureau, which was recommended by the Governor in his message, but while that body showed a disposition to do so the effort failed for reasons well known, and it was found, in the extra session which followed, that no appropriation could be made without amending the original Act, which could not be done at an extra session. In the month of February, 1882, the State Mineralogist wrote to the Governor, stating the decrease of the Mining Bureau Fund, and informing him that it would be impossible to maintain the efficiency of the institution on the income, since which time he has been compelled to practice the utmost economy without sacrifice to the interests of the State, and has tried to accomplish personally as much as possible of the labor of the different departments, to the best of his ability.

It was thought best to keep the museum open until the meeting of the following Legislature, the more so as it was found that it could not be closed without incurring considerable expense, and as the replacing of the museum material would entail considerable loss to the State.

A bill was introduced in the Senate asking for an appropriation of $11,000 yearly, for two years, which was reduced by that body to $5,000 per annum, in which form it became a law. The reduction was made by the Senate committee, on the assumption that the tax transfer fund would not fall below that of the quarter preceding their visit to the bureau, which was about $1,700, or $540 per month; but it has continued to decrease, and there is reason to believe that it will diminish indefinitely. It is the experience made by the management, that the original Mining Bureau Fund cannot be depended upon, and should not be taken into future calculations. It is collected three months after it has accrued, and, as the institution was started three months before any money was paid in to its credit, the fund for six months is a part of the assets and must be used in the payment of expenses due.

To close the museum, even for a year, would be to take a step backward; and, while it would not, perhaps, otherwise impair the usefulness of the Mining Bureau, such a retrograde movement would entail a loss, not only as regards the labor expended in bringing the museum to its present state of perfection, but to this must be added the cost of packing, and the labor requisite when it was again opened. To allow the museum in this advanced state to close would be almost as serious a mistake as the discontinuance of the Geological Survey, which has always been a regret to thinking citizens. Many persons have donated largely to the State Museum with the understanding that their contributions should be cared for by the State and kept on permanent exhibition. It would not be keeping faith with them if their valuable gifts should be hidden away for an indefinite period, and it would be a shame now to hide all the beautiful and valuable specimens which have been acquired.

The State Museum has only been brought to its present condition by much labor and no inconsiderable expense. As now arranged it will compare favorably with those of other countries, according to the verdict of many persons who have visited similar institutions both at home and abroad; yet there are other specimens on hand, classified and arranged, in sufficient numbers to double those now on exhibition. They are packed in boxes in another room, and await the purchase of cases for their display. The specimens already in the museum are crowded for want of case room. They should occupy from six to ten cases more, to show them to the best advantage. This could be easily and quickly done if the money was forthcoming to pay for the extra cases. The boxed specimens could also be displayed within a month if the necessary funds were provided.

This is not the first effort that has been made to establish a State Museum of Geology and Mineralogy in California. The legislative Act which created the Geological Survey made it the duty of the State Geologist "to collect the rocks, fossils, soils, and minerals of the State, and its zoölogical and botanical productions, to be deposited in such place as should thereafter be provided for that purpose by the Legislature;" but such provision was never made, and the valuable collections of the survey were stored in a warehouse which was destroyed by fire. Thus a great loss was sustained by the State. Professor Whitney, in a lecture in the City of San Francisco in 1864, called attention to the importance of a State Museum, and it was not his fault that the plan was not carried out.

The success of the Mining Bureau Museum proves that such an institution is wanted by the people. In no other country could so large and varied a collection be made in so short a time, for in no other country are so many prospectors interested in having ores and minerals they discover placed on exhibition. The collection, with the library and other State property, is certainly worth more than the cost of the institution. The whole of the property acquired up to the present time has been derived from the mining community, but it now belongs to the State. This should be a consideration for other classes, who are equally benefited, to come forward and assist in making the State Museum the great institution it deserves to be.

The founding of museums for education and display of national resources, is almost universal, and it is not to be supposed that the whole world is mistaken, or has been in the past.

What applies to other countries applies equally to California, for if there is any State that needs to show up her natural resources it is California; for she has long invited capital from abroad, and begins to wonder why her population is so small while her natural advantages are so great.

To the average inhabitant of the earth our State is either wholly unknown, or is regarded as a vast region of desert lands, valuable only for the mines of gold and silver found in them. Even men of education and science make serious mistakes in regard to California; as, for instance, in Dana's Geology, which is considered a standard work on that subject, it may be found stated that "chrome iron occurs in the serpentines of California, but not in a condition to repay mining;" while, on the contrary, that important and scarce mineral is largely mined and exported.

There have been so many mistakes regarding the character of our mining districts, and so many misstatements to those who have been asked to invest their capital in California, that there is need of an official source of information relating to the varied resources of the State. This can best be accomplished by granting to the institution already established a liberal support.

The Mining Bureau was located at San Francisco because it was thought that the museum would be more accessible to the people of the State generally. It has already been of benefit to the city, and can be made more so if it meets with the encouragement it deserves.

Both Arizona and Colorado are considering the establishment of a State Mining Bureau on a similar plan as ours, and a national association has been organized, the object of which is, in part, to encourage State Museums. The State of New York gave its credit, and appropriated $3,500 per annum as interest on the sum required for the museum buildings in Central Park, and a further amount of $500,000 for equipping and furnishing the same, to which the citizens have also largely contributed.

St. Louis has recently subscribed $483,000 for a building for similar purposes.

In the encouragement of a State Museum in which all the natural resources of the State should be placed on permanent exhibition, San Francisco should take the most active part, because she has received the compliment of having the Mining Bureau placed within her limits.

While the institution has been called the "Mining Bureau," and so far, has been paid for by the miners, its usefulness has been general, and the merchant, manufacturer, and the agriculturist are, or should be, deeply interested in its success.

In order to manufacture to advantage, crude material must be both abundant and cheap, and, as far as possible, should be found within the State borders. It is now known that gold and silver are not the only metals in the State worthy of attention, but that other ores having an economic value are abundant. Many such instances have been made known through the agency of the State Mining Bureau. It ought not to be true that we waste enough in California to make the entire population comparatively rich.

The Mining Bureau has grown out of all proportion to the provision made for its support, and quite beyond the expectations of its friends; but the management now finds itself in the anomalous position of being compelled to retard its progress rather than to push it forward.

It has long been evident that the State Museum was becoming too extensive and valuable to be managed by a single individual. The experience of the last three years has shown that there is a great future for the institution, if properly managed, and it is well worthy of the fostering care of the State. But it has already become so extended in its scope that no person is competent to manage it without the advice and assistance of others. Under this conviction I asked, in my last report to the Governor, "that a Board of Trustees be appointed to share the responsibility and management of the State property, leaving the State Mineralogist free to travel, to investigate and report upon new discoveries, and to conduct the scientific departments with his assistants." This was recommended by the Governor in his message, and, although no action was taken, I am still as strongly impressed with its importance as before.

It is clear to my mind that the time has come when the State Mining Bureau should be reorganized and placed on a permanent basis, or the museum closed, and the institution and office of State Mineralogist abolished. In view of these considerations, and not wishing to bear the whole responsibility, I called a meeting of prominent citizens, asking them to act with me as an advisory committee, and to whom I set forth the above stated facts. The following letter was addressed to the gentlemen named below:

CALL MADE TO CITIZENS TO TAKE INTO CONSIDERATION THE AFFAIRS OF THE STATE MINING BUREAU.

California State Mining Bureau,
Office of State Mineralogist,
San Francisco, March 23, 1883.

Dear Sir: You are hereby invited to meet with a number of other prominent gentlemen of this city, at the rooms of the State Mining Bureau, 212 Sutter Street, on Monday, March twenty-sixth, at three o'clock, to act as an advisory committee, to take into consideration the future of the State Museum. The matter to be laid before the committee is of great importance to the State.

Hoping that you can spare time for this purpose,

I remain very truly,

HENRY G. HANKS,
State Mineralogist.

CITIZENS TO WHOM THE ABOVE LETTER WAS SENT.

George C. Perkins,
J. Z. Davis,
George T. Marye, Jr.,
A. B. Paul,
C. Waterhouse,
Cornelius O'Connor,
Capt. J. M. McDonald,
S. Heydenfeldt, Jr.,
Horace Davis,
William T. Coleman,
Mayor Washington Bartlett,
A. Hayward,
A. P. Brayton,
Col. J. P. Jackson,
Malter, Lind & Co.,
William T. Garratt,
John H. Carmany,
W. B. Ewer,
L. L. Bullock,
Judge J. S. Hager,
H. A. Cobb,
R. H. Sinton,
J. M. Keeler,
W. M. Bunker,
Alexander Boyd,
Robert N. Graves,
George W. Grayson,
Melville Attwood,
Charles M. Tyler.

A preliminary meeting was held at the rooms of the State Mining Bureau, 212 Sutter Street, March 26, 1883. The following gentlemen were present: George T. Marye, Jr., Melville Attwood, W. M. Bunker, J. H. Carmany, William T. Coleman, J. Z. Davis, W. B. Ewer, S. Heydenfeldt, Jr., J. M. Keeler, J. M. McDonald, A. B. Paul, and Charles M. Tyler.

Mr. William T. Coleman was called to the chair, and S. Heydenfeldt, Jr., acted as Secretary. The object of the meeting was stated, and, after due discussion of the affairs of the bureau, a committee of five was appointed, consisting of Messrs. Paul, Heydenfeldt, McDonald, Bunker, and Tyler, as a Committee of Ways and Means, to devise some plan of appealing to the citizens of the State to come forward and assist in maintaining the Mining Bureau until the next session of the Legislature.

After expressing the sense of the meeting as to the value of the State Mining Bureau, and that every effort must be made to maintain its usefulness, the meeting adjourned.

A second meeting was held April sixth to receive the report of the committee, at which it was proposed to hold a Pacific Coast Mineral Exposition during the Triennial Conclave of the Knights Templars in August, and to appeal to the miners of the State to contribute specimens and funds to carry out that end, in the belief that the needed aid would at the same time be extended to the Mining Bureau. A new committee was formed, consisting of the following gentlemen:

Geo. T. Marye, Jr., Irving M. Scott, S. Heydenfeldt, Jr., Almarin B. Paul, Lloyd Tevis, Melville Attwood, L. L. Bullock, W. M. Bunker, William T. Coleman, James V. Coleman, C. O'Connor, Jacob Z. Davis, John Daggett, Warren B. Ewer, C. A. Hooper, W. H. Mills, J. R. Scupham, Charles M. Tyler.

The members of the committee signed the following agreement: "We, the undersigned, hereby consent to act as a committee for the purpose of encouraging an exposition of the mineral wealth of the State, and to extend the scope and usefulness of the *State Mining Bureau.*"

On motion, it was decided to address the several counties of the State, the address to be prepared and submitted to the committee for consideration and approval, and that the committee be empowered to take such action in forwarding the object in view as they may consider most efficacious and suitable.

April seventeenth a meeting was called by the Secretary of the Citizens' Committee. Geo. T. Marye, Jr., was elected Chairman; Irving M. Scott, Vice-Chairman; S. Heydenfeldt, Jr., Secretary; A. B. Paul, Corresponding Secretary, and Lloyd Tevis, Treasurer. The Chairman appointed an Executive Committee, consisting of Messrs. Paul, Bunker, Heydenfeldt, Jr., and Davis; Auditing Committee—Messrs. Attwood, Bullock, and Ewer. Circular No. 1 was approved and five hundred copies ordered printed, one of which was sent to the Supervisors of each county in the State.

[*Circular No.* 1.]

Rooms of the Citizens' Committee of the
Pacific Coast Mineral Exposition,
212 Sutter Street, San Francisco.

To the honorable Board of Supervisors of the County of ———, State of California, greeting:

We, the undersigned, a committee of citizens of the City and County of San Francisco, called by Henry G. Hanks, State Mineralogist, to consult upon the vital importance of making a grand free exposition, or display, of the mineral and material resources of the Pacific Coast, which shall be a credit and benefit to our great State and to the Pacific Coast, to be held at San Francisco during the coming Summer, when our metropolis will be filled with distinguished and influential visitors from abroad, have deemed it just and wise to address the respective Boards of Supervisors of the several counties, and through them the citizens, that no portion of the State may fail of the honor and benefit of an equal and full representation in this important and attractive display. We therefore respectfully call your attention to the reasons and considerations which have influenced the committee, viz.:

Whereas, The provisions made for the support of the State Mining Bureau by the Act which brought it into existence, even adding the recent legislative appropriation, are entirely inadequate for the purpose, and are insufficient for the conduct of the institution in any way commensurate with its splendid advancement and fine acquisitions of new material and valuable specimens; and whereas, the coming Summer will afford one of the great opportunities of an age for a noticeable and important free display of our mineral and material interests; and whereas, we have been impressed with the importance of so arranging the specimens that those of each county may be displayed together, an arrangement which cannot now be made for lack of cases; therefore we most respectfully lay before your honorable body the result of our deliberations, viz.:

First—It is proposed that the citizens of the City and County of San Francisco (and liberal-minded citizens of the State who may so desire) raise all the funds required to project and carry out a Free Pacific Coast Mineral Exposition, and make the display one of unequaled attraction and interest to all who may visit the city.

Second—That the respective counties, and the citizens thereof, be earnestly solicited to contribute the sum of one hundred dollars for each county—by appropriation or by private subscription—which may be sent to Lloyd Tevis, Esq., Treasurer of this Citizens' Exposition Committee, to go into what will be styled "The County Case Fund of the State Mining Bureau and Museum," to provide neat and uniform cases, which will bear the names of the respective counties so contributing.

It is also most earnestly requested that immediate measures be taken by the respective Boards to solicit specimens, which may be sent by express, free, directed to the State Mining Bureau, with names of donors, which will appear on printed display cards in the respective county cases.

Many relics, fossils, etc., will no doubt be sent which cannot go in cases, and for these a county space will be assigned by the committee.

Believing that the main thoughts aimed at and brought out in this circular will afford an ample incentive to earnest and practical effort, and that opportunity will be furnished for one of the most important displays the State has ever made, we submit this circular, hoping that what it asks for and aims at will meet with your approbation and receive your hearty coöperation.

We are, gentlemen, yours very respectfully,

MELVILLE ATTWOOD,
L. L. BULLOCK,
W. M. BUNKER,
WM. T. COLEMAN,
JAMES V. COLEMAN,
C. O'CONNOR,
JACOB Z. DAVIS,
JOHN DAGGETT,
WARREN B. EWER,
S. HEYDENFELDT, Jr.,
C. A. HOOPER,
GEO. T. MARYE, Jr.,
W. H. MILLS,
ALMARIN B. PAUL,
I. M. SCOTT,
J. R. SCUPHAM,
CHAS. M. TYLER.

Letter accompanying Circular No. 1:

PACIFIC COAST MINERAL EXPOSITION.

Rooms of the Citizens' Committee, 212 Sutter Street,
San Francisco, April 21, 1883.

To the Clerk of the Board of Supervisors, ——— County, California:

Dear Sir: Inclosed please find circular letter in triplicate, addressed to your honorable Board of Supervisors. I believe it will be your pleasure to send the same to the gentlemen of the Board in their respective districts, if they are not at the county seat, retaining one for yourself that you may be able to advocate the purpose set forth. An early response is earnestly desired.

Very respectfully,

S. HEYDENFELDT, Jr.,
Secretary of Committee.

A special committee was appointed to draft Circular No. 2, informing the public that an exposition would be held, and Circular No. 3, giving instructions how to pack and send specimens, both of which were accepted, ordered printed, and sent to the several county seats, and to every newspaper published in the State. A large number were reserved for distribution in the city.

[*Circular No.* 2.]

PACIFIC COAST MINING EXPOSITION.

Rooms of the Citizens' Committee,
212 Sutter Street, San Francisco.

During the session of the Triennial Conclave of the Knights Templars, to be held in San Francisco during the month of August, 1883, it is variously estimated that from 15,000 to 50,000 strangers will visit this city.

In view of this unusual influx of visitors there has been inaugurated by the citizens of San Francisco a Pacific Coast Mineral Exposition, to be held in this city and kept open daily, for the free admission of the public, during the month of August.

The exhibits will be in two general classes, viz.: Donations to the State Museum, which will remain on permanent exhibition after the close of the exposition; and loan exhibits, which will be returned to the owners at the close of the exposition.

In order to make the exposition worthy of our State, all citizens are requested to take a personal interest therein, and forward, either directly to the State Mining Bureau, or through their own county committee, any specimens which may represent any of the resources of the State or are of interest otherwise.

It is desirable to exhibit specimens of all ores occurring in the State, such as gold, silver, copper, lead, antimony, tin, nickel, quicksilver, iron, etc.; also clays suitable for brick, fire-clay, pottery, porcelain, etc.; useful and ornamental stones for building, paving, and statuary, lime, plaster, etc.; cements, natural and artificial, mineral oils, crude and manufactured; soda and borax, crude or manufactured; nitrates, chromic iron, rocks and minerals of all kinds, salt, coal, fossils, woods, native and cultivated, fibrous plants, native and cultivated; paper material, native and cultivated; tanning material, native and cultivated; sands suitable for glass-making, etc.; mineral soap, soapstone, Indian relics, and specimens of curious natural formations of any kind that may be interesting.

Information regarding packing, etc., may be found posted up in your Post Office, and copies of these directions may be had of the Postmaster, or of the regularly appointed committee of your county.

Specimens will be received from this date until August 1, 1883, for exhibition during the exposition.

The Citizens' Committee is as follows:

GEORGE T. MARYE, Jr., Chairman,
IRVING M. SCOTT, Vice-Chairman,
S. HEYDENFELDT, Jr., Secretary,
ALMARIN B. PAUL, Corresponding Secretary,
LLOYD TEVIS (Pres't Wells, Fargo & Co.), Treasurer,
MELVILLE ATTWOOD,
L. L. BULLOCK,
W. M. BUNKER,
WILLIAM T. COLEMAN,
JAMES V. COLEMAN,
C. O'CONNOR,
JACOB Z. DAVIS,
JOHN DAGGETT,
WARREN B. EWER,
C. A. HOOPER,
W. H. MILLS,
J. R. SCUPHAM,
CHARLES M. TYLER.

[*Circular No.* 3.]

PACIFIC COAST MINERAL EXPOSITION.

Directions to Exhibitors.

1. Specimens should not be less than two inches in diameter, excepting very rare or valuable minerals.
2. Wrap each specimen up carefully in paper, with a label inclosed, stating locality as exactly as possible—section, township, and range, and name of county—also the name of donor.
3. When two or more specimens are sent at the same time, observe Rule 2, and pack together tightly so as to avoid any rubbing of the specimens.
4. When a number of specimens are sent in one box, in addition to the regular label (Rule 2) have them numbered and a list of corresponding numbers made out and sent in the box.
5. Tack on the regular address card of the State Mining Bureau, or address "State Mining Bureau, 212 Sutter Street, San Francisco."
6. Use every precaution in sending fragile specimens; pack separately in small box so that they do not damage from defective packing.
7. Before sending unusually bulky or weighty specimens, correspond with the Secretary of the committee concerning same.
8. Advise the State Mining Bureau of every shipment, stating when and how the shipment was made.
9. Send all small packages of twenty pounds or less by Wells, Fargo & Co.'s Express, and charges will be attended to at this office.

April twenty-fourth a meeting was held for general consultation, at which it was decided that all matters of detail be left to the Executive Committee, who were instructed to proceed in arranging the business of the exposition, and to procure the necessary material and assistance for advancing the same. April twenty-sixth a meeting of the Executive Committee was held, and the following resolutions adopted unanimously:

Whereas, San Francisco will be visited by many thousand people in consequence of the holding of the Triennial Conclave of Knights Templars during the month of August of this year, and the committee deeming it advisable to have the mineral wealth of the Pacific Coast fully represented, and exhibited by the State Mining Bureau; therefore, be it

Resolved, That the Executive Committee appointed by the Chairman of the Citizens' Committee, Geo. T. Marye, Jr., solicit and collect subscriptions of money, and procure mineral specimens in addition to those now in the museum of the State Mining Bureau, for the purpose of having exhibited a representative collection of the minerals of this coast, to be made as full and complete as practicable; and to increase the scope of the Mining Bureau, and to aid it in disseminating useful information.

Be it further resolved, That all moneys collected by the Executive Committee, or by any member thereof, be deposited with *Mr. Lloyd Tevis,* Treasurer of this committee, to be expended and applied for the purposes aforesaid, and expressed by the said Executive Committee at its regular and special meetings, and that all specimens received shall be given to the State Mining Bureau, excepting such as may be loaned to the exposition.

Be it further resolved, That the said Executive Committee be and is hereby authorized and empowered to issue letters and circulars setting forth the importance of carrying out the objects contemplated in the foregoing resolutions.

Be it further resolved, That a copy of these resolutions be sent to the Supervisors of every county in the State, requesting their coöperation, and that the press of the State be urged to give publicity to the objects which the committee has in view.

THE HONDURAS EXHIBIT.

About the date of this report his Excellency Marco A. Soto, President of the Republic of Honduras, arrived in San Francisco with a large and valuable collection of the ores, minerals, fossils, woods, fibers, manufactures, etc., of his country, and a very interesting collection of antiquities from the ancient City of Copan. He applied to the Mining Bureau for the privilege of exhibiting his collections in the State Museum, which was granted. The exhibit, which was a very fine one, remained in the museum for a number of days. On removing the specimens many duplicates were presented to the State Museum by President Soto, constituting a fair representation of the entire Honduras exhibit, and including a full set of the woods of the country, which in itself is a very valuable donation. The collection of antiquities, filling two museum cases, was loaned to the museum for an indefinite period, and will remain on exhibition. It forms an attractive feature of the museum, supplementing as it does the State collection of antiquities.

Among the minerals shown by President Soto were some remarkably fine opals, for which Honduras is celebrated; a large exhibit of placer gold, and cakes of silver obtained from the cupellation of lead reduced from galena. Also some beautifully chased silverware, the manufacture of Hondurians, both ancient and modern.

The ruined City of Copan is in the department of Gracias, Honduras. The ruins lie in a dense forest, and cover an area extending for two miles on both sides of the Copan River, a branch of the Motagua, from which the city takes its name.

Among the wonderful ruins are the partly fallen walls of a great building 624 feet long, supposed to have been a temple. The inclosure is well paved with blocks of cut stone.

From the river to the temple there is a grand stairway of cut stone, and many monoliths of great size, covered with hieroglyphics in an unknown language, are found near by, many of them still standing. These monoliths, which are elaborately sculptured and very ornamental, are peculiar to Honduras, and their meaning and history are probably given in the unread inscriptions which await an unfound rosetta stone or other key to the deeply cut hieroglyphics. At the time of the Spanish conquest the conquerors found these ruins in their present condition, without a history and with scarcely a tradition.

Among the numerous specimens loaned by President Soto to the State Museum are grotesque ornaments in baked clay, ornamented vessels of the same material, vessels cut in stone, fragments of the characteristic monoliths above mentioned, and ornaments and designs showing both taste and skill on the part of the ancient sculptors. A very remarkable and beautiful corn mill of diorite is shown with roller of stone, upon which the modern rolling pin is no improvement. On the gracefully curved face of the mill, cakes or flat sheets of bread were prepared. The character of this beautiful utensil is such, and the amount of labor expended in its construction so great, that none but a person of wealth or high position could have owned it.

Another remarkable carving is that of a sphinx, which seems to prove that the ancient people were in communication, direct or indirect, with the Egyptians, and it seems as likely that the latter derived their idea of that fabulous monster from the citizens of Copan, as the reverse.

VISITORS.

Since the last report the number of visitors has notably increased, the museum becoming more widely known. From the commencement up to June first, 8,172 names have been entered in the register. But this by no means represents the number of visitors, for an unaccountable reluctance to register has been noticed, and those who have previously visited the museum frequently decline to enter their names again. There is no way of keeping a record of the visitors, while no regular museum attendant is employed. It is safe to estimate five visitors for each name registered. Many persons daily visit the offices of the Mining Bureau for information and on business who do not enter the museum.

DEATH OF JOSEPH WASSON.

Since the publication of the last report the Honorable Joseph Wasson, to whom is due the founding of the State Mining Bureau, died in Mexico. The date of his death was April 18, 1883. He was appointed United States Consul for the port of San Blas, and his friends thought the change of climate would restore his failing health. This hope, unfortunately, proved groundless. However great the State Mining Bureau may become in the future, the name of Joseph Wasson will always be associated with its commencement.

Mr. P. L. Peters, a well known artist of San Francisco, offered to paint, gratuitously, a portrait of Mr. Wasson from a photograph taken before his death. He has produced an admirable likeness, which has been hung in the library of the State Mining Bureau as a part of the history of the institution.

This incident suggested the idea of obtaining and preserving portraits of all those connected with the geological surveys of the State. To this end a small photograph of Dr. J. B. Trask, first State Geologist of California, was obtained from his wife and enlarged and retouched by C. E. Watkins, of San Francisco, which is now also framed and hung in the library. A letter was written to Professor J. D. Whitney, former State Geologist, asking for his photograph, and he has promised to send it, but up to the present time it has not been received. These portraits will be more prized in the future than now.

ANTICIPATED REMOVAL.

Notice has been given to the State Mineralogist that the building now occupied by the State Mining Bureau will soon be remodeled, and that it will be necessary for the museum and offices to be removed during that time. No date has been set for the work to commence, but removal is only a question of time. The work will probably be commenced immediately after the Winter rains.

To move the museum implies the packing in boxes of all the museum material, and replacing it again in the new rooms. To those who have had no experience, the magnitude of this work cannot be realized; nor can it be done without loss, for some of the specimens are so fragile that they may become broken, notwithstanding the greatest care. The Mining Bureau has before been compelled to remove at short notice, and for the same reason. It will be very difficult to find rooms suitable for the purpose, and at the present this seems almost impossible. Unless there is some provision made for a permanent building, there seems to be no alternative but to pack the specimens in boxes and store them for an indefinite period. But such a course would be a serious blow to the institution, and one from which it would not soon recover.

DANGER OF FIRE.

In my second report I alluded to the danger of fire, and the great loss the destruction of the museum would be to the State. The importance of this subject becomes greater with the increase of the collections. It is a question whether it would not be better to sacrifice accessibility to safety, and to remove the museum to the Park or other locality with less risk of fire. To test the practicability of such a move, I made application to the Park Commissioners, asking them if a building could be furnished, but as yet have received no reply.

The museum should as soon as possible be placed in a suitable building, which should be absolutely fireproof.

STATE MAP.

In a recent report, the State Engineer called attention to the large map of California in his office. This is a very valuable work, and one that is not fully appreciated by the people.

It is proposed to issue the map in sections, which should furnish the groundwork for all future maps of the State. Each County Surveyor should be furnished with sheets, upon which he could fill in the details of his county surveys. The State Mineralogist should have sheets, upon which the results of his study of the geology of the State could be entered from time to time, and the locality of all known minerals marked.

The want of such a map is daily felt in this office. The United States map of California, used by the State Mineralogist, was sent to the State Engineer, who has marked upon it lines showing the sheet sections of his great map.

It is to be hoped that early action will be taken to furnish sectional sheets to all those working in the interest of the State.

ECONOMIC CONSIDERATIONS.

It is beyond question that mining and metallurgy as practiced in California are wasteful and extravagant. The amount of gold lost in milling and hydraulic mining is much greater than is generally admitted. As an example of the latter I give a statement recently made to me:

May 26, 1883, Mr. C. H. Hankins, of Nevada County, called at the State Mining Bureau and stated that he had, during a period extending from 1869 to date, taken $125,000, in gold, wholly from tailings rejected by the Bird's-eye Creek Hydraulic Mining Company, at You Bet, Nevada County, in this State. After saving all he could, his tailings still contained gold, which would pay to work, but which were no longer on his ground. He employs the same water used by the hydraulic company, and in the same kind of sluices.

For five or six years the gross yield per annum has been $16,000. He has never seen *rusty gold*, and knows nothing of the subject. The hydraulic company uses 1,500 inches of water.

Mr. Hankins thinks the large quantity of gold in the tailings could be recovered by ground sluicing, even if hydraulic mining should be stopped. His plan is to commence at the lower end of the cañon, which is a mile or more long, and to sluice out the tailings, now seventy-five feet deep. The gold is very fine.

Professor Edison was the first, I believe, to call public attention to the presence of gold in tailings from hydraulic mines, in a condition invisible to the eye, and in considerable quantities. In June or July, 1879, he sent letters to many hydraulic mines in California, and to individuals, asking for information, and for samples of platinum, which he found indispensable in his electric light inventions. This led to his receiving many samples, in some of which he found large proportions of gold, as stated. He then invented an apparatus for separating the magnetic particles, figured in the Mining and Scientific Press of June 15, 1881, and in the Popular Science Monthly of a recent date. At the time, I thought he was mistaken as to the quantity of gold, or had based his opinion on an accidental specimen of unusual richness. But recent experiments made by myself, and others by Mr. A. B. Paul and Melville Attwood, have fully sustained him. It is difficult to understand how hydraulic miners have generally overlooked this great loss.

It has long been known that placer miners did not save all the gold, and instances are numerous in which they have washed the same ground several times, realizing a crop of gold from each washing nearly as great as the first. But it has been claimed that with improved appliances, hydraulic miners saved nearly all of the precious metal. Few Superintendents are willing to admit a loss greater than fifteen per cent. Mr. Hankins' success, and the discovery by Professor Edison, show the fallacy of this estimate.

The more that hydraulic sands are studied the more interesting the subject becomes. Realizing this, I have collected sands from many parts of the State for future study and reference. The question of slickens and mining debris as antagonistic to agriculture, is one of great importance to the State. It has been thought best to study the soils as well, to learn any lesson they may teach as to the natural disintegration of the rocks, which seems to have been generally overlooked in the more important study of slickens and debris, produced by artificial means. I have prepared, also, several sets of microscopic slides, as shown in the following extract from the museum catalogue. One set of each has been sent to the following institutions:

The Geological Society of England.
The Geological Society of France.
The Royal Microscopical Society of London.
The Microscopical Society of San Francisco.
And one set retained in the State Museum.

MICROSCOPE SLIDES,

Showing the condition of Alluvial Gold as collected in Hydraulic, Placer, and Drift Mining in California, with associate minerals found in "cleaning up" the sluices, as described in the Reports of the State Mineralogist of California. (Presented by the California State Mining Bureau.)

4556.—Microscope Slide. Crystallized Gold, White Bull mine, Linn County, Oregon. See Report State Mineralogist for 1882, folio 144.

4557.—Microscope Slide. Gold Crystals after stibnite. (?) Lake mine, Napa County, California. Several pans of dirt were taken from the gulch, washed down in a miner's pan to a small quantity, a portion of mercury added, the mercury separated without rubbing, and boiled in nitric acid; these pseudomorphic (?) crystals remained. An attempt was made to produce similar crystals by treating precipitated gold in the same manner, but without success.

4558.—Microscope Slide. Gold from a quartz mine, Beverage, Inyo County, California. Some of the gold is rolled into cylinders under the muller while being crushed.

4559.—Microscope Slide. Placer Gold from upper San Joaquin River, Fresno County, California. This gold is fine and free from coating, except to a slight degree on some of the pieces. It shows a tendency to crystallize.

4560.—Microscope Slide. Placer Gold, San Luis Obispo County, California. Very pure and free from coating.

4561.—Microscope Slide. Placer Gold from shores of Mono Lake, Mono County, California. This gold is remarkably pure and free from coating. It amalgamates perfectly and immediately on being brought in contact with mercury.

4562.—Microscope Slide. Placer Gold, Chile Gulch, Calaveras County, California. This gold is in a cryptocrystalline state not easy to account for. Many of the grains inclose quartz, which would seem to indicate that it has its origin in some quartz vein in the immediate vicinity. It differs from ordinary placer gold, and may have been collected by mercury and overheated in the retort. The Mining Bureau has no history of this specimen more than is shown in the label.

4563.—Microscope Slide. Electrum, Bodie, Mono County, California. See First Annual Report of State Mineralogist, folio 25.

4564.—Microscope Slide. Gold and Platinum, beach at Coos Bay, Coos County, Oregon. See Report of State Mineralogist for 1882, folio 252.

4565.—Microscope Slide. Typical specimen of Coated or "Rusty" Gold, Red Hill Hydraulic Mine, Butte County, California. All attempts to collect such gold by amalgamation results in failure; for this reason a large proportion of the placer gold, and especially that from the ancient river beds, is lost to the world. The loss is so great, and the matter so serious, that miners, inventors, and scientific men should devise some plan by which such gold may be saved. Attention is called to this subject in Report of State Mineralogist for 1882, folio 117.

4566.—Microscope Slide. Rusty or Coated Gold, from a large deposit of tailings below Oroville, Butte County, California. Described in First Annual Report of State Mineralogist, folio 39. It may be seen that the particles of gold are not to the same extent coated, but that all are more or less so.

4567.—Microscope Slide. Placer Gold from the Bonanza Hydraulic Mine, Gold Run, Placer County, California, collected in crevicing. The particles are considerably coated. Crevicing has been described in Report of State Mineralogist for 1882, folio 113.

4568.—Microscope Slide. Placer Gold, coated with silica by pressure and friction, from the Blue Lead bedrock, below the gravel, Chalk Bluffs, Nevada County, California.

4569.—Microscope Slide. Placer Gold with pyrite and magnetite, Nevada County, California. The gold is, to a considerable extent, coated.

4570.—Microscope Slide. Hydraulic Gold, amalgamated and boiled in nitric acid, by which the mercury was dissolved. The product is beautifully crystallized. The gold used was amorphous.

4571.—Microscope Slide. Gold precipitated from solution of sesquichloride by solution of protochloride of iron.

4572.—Microscope Slide. Precipitated Gold (see No. 4571), amalgamated and boiled in nitric acid. It is cryptocrystalline, but in no way resembles No. 4570, or No. 4557, which might be expected.

4573.—Microscope Slide. Gold (portion E, Report of State Mineralogist for 1882, folio 114) from Spring Valley Hydraulic Mine, Butte County, California. This gold was in the form of amalgam, from which the mercury was volatilized by heating to redness in a porcelain capsule.

4574.—Microscope Slide. Platinum with indosmine, Mormon Island, Sacramento County, California.

4575.—Microscope Slide. Platinum and iridium. Concentrations from Spring Valley Hydraulic Mine, Cherokee, Butte County, California. See No. 4224, and Report of State Mineralogist for 1882, folio 252.

4576.—Microscope Slide. Concentrations from placer washings, Chiquita Joaquin, Fresno County, California. Containing zircons with gold; curious as showing gold in two conditions, as pure gold, or nearly so, and as electrum, a natural alloy of gold and silver. See No. 4563.

4577.—Microscope Slide. Gem Sand (so called), Lower Gold Bluffs, Humboldt County, California. Containing gold, platinum, magnetite, chromite, quartz, zircons, and red crystals. It is the result of natural concentration by the action of the waves on the ocean beach.

4578.—Microscope Slide. Concentration from Spring Valley Hydraulic Mine, Cherokee Flat, Butte County, California. (Portion D.) Zircons picked out by hand. See Report of State Mineralogist of 1882, folio 114.

4579.—Microscope Slide. Zircon Sands, Amador County, California. Concentrated in placer mining.

4580.—Microscope Slide. Dune Sands, San Francisco, California. Described in Report of State Mineralogist of 1882, folio 196. All, or nearly all, of the grains are rounded. In this deposit, which is quite extensive near the City of San Francisco, there are beds of iron sands in varying stages of decomposition, showing how some sandstones are mottled and become shaded in process of induration.

4581.—Microscope Slide. Fine Sand from the Colorado Desert, San Diego County, California. The grains are rounded by the action of both water and wind. See Report of State Mineralogist for 1882, folio 236.

4582.—Microscope Slide. Fine Sand from Spring Valley Hydraulic Mine, Cherokee, Butte County, California. All the grains are angular.

4583.—Microscope Slide. Fine Quartz Sand from the Polar Star Hydraulic Mine, Dutch Flat, Placer County, California. (Portion H, after boiling in nitric acid.) See Report of State Mineralogist for 1882, folio 101. All the grains are sharp and angular.

4584.—Microscope Slide. Tryonia clathrata. Tertiary fossils mentioned in Report of State Mineralogist of 1882, folio 229. Colorado Desert, San Diego County, California.

4585.—Microscope Slide. Placer gold with globular pyrite in the form of sand. Last Chance Mining District, Placer County, California. This gold is but slightly coated. The small concavities are in some cases coated with silica, and some grains show the pyrite attached. The gold is remarkably fine, probably the most so of any in the State, being 996 fine. The pyritic sand is very interesting when examined microscopically. This association is rather rare. The exact locality is section 34, township 15 north, range 12 east, Mount Diablo meridian.

Mr. Attwood has made a special study of No. 4557 of the above catalogue, from the result of which he thinks it to be amalgam, and not a pseudomorph, as at first supposed.

To obtain soils for microscopic examination, circulars were sent to the following Post Offices, from nearly all of which samples were received. This collection of soils is highly interesting, and there is sufficient quantity of each to admit of a chemical analysis when a suitable laboratory is provided:

POST OFFICES TO WHICH CIRCULARS WERE SENT ASKING FOR SAMPLES OF SOIL.

1. Alma,
2. Altoona,
3. Allendale,
4. Bakersfield,
5. Ballena,
6. Bath,
7. Bear Valley,
8. Bellota,
9. Benton,
10. Bieber,
11. Bolinas,
12. Bullards Bar,
13. Burgettsville,
14. Crescent City,
15. Caliente,
16. Calistoga,
17. Calpella,
18. Capell,
19. Carpenteria,
20. Cedarville,
21. Cherokee,
22. Cholame,
23. Cisco,
24. Citrus,
25. Clarksburgh,
26. Clayton,
27. Clear Creek,
28. Cloverdale,
29. Coloma,
30. Columbia,
31. Coyote,
32. Downieville,
33. Davenport,
34. Douglas City,
35. Drytown,
36. Dunnigan,
37. Eureka,
38. Elder Creek,
39. Elk Creek,
40. Elliott,
41. Emmett,
42. Etna Mills,
43. Fairford,
44. Farmersville,
45. Felton,
46. Forest Home,
47. French Camp,
48. Geyserville,

49. Glencoe,
50. Grayson,
51. Gualala,
52. Hueneme,
53. Judsonville,
54. Kernville,
55. Kingston,
56. Lakeport,
57. Los Baños,
58. Linden,
59. Markleeville,
60. Milton,
61. Meadow Valley,
62. Minersville,
63. Mohawk,
64. Mono,
65. Monticello,
66. Moons Ranch,
67. Newberry Park,
68. Princeton,
69. Poway,
70. Quincy,
71. Requa,
72. Ripon,
73. Rock,
74. Soquel,
75. Susanville,
76. Soledad,
77. San Luis Obispo,
78. Santa Barbara,
79. San Bernardino,
80. Saticoy,
81. Tehama.

A serious loss of gold attends the milling of quartz, even in the best mills of the State, but I am not prepared to state to what extent. The principal loss occurs in the concentration, roasting, and chlorination of the sulphurets containing gold, which are not decomposed in the process of milling, but which require special treatment as above. This loss arises from several causes: First—From defect in the concentration, which in many cases is unskillfully done. Second—Roasting, in which a serious loss results from the volatility of the gold, as proved by the specimen in the museum of the State University, and mentioned on folio 152 of the Second Report of the State Mineralogist. The sulphur, too, is wasted—a very valuable product, which should be saved, and made into sulphuric acid, to be used in the metallurgy of the very ores from which it is extracted. Third—In the operation of chlorination the loss of gold is known to be considerable. The roasted sulphurets, after treatment to extract the gold, are thrown aside as worthless, when they contain iron in the condition best suited for its extraction by sulphuric acid, to obtain green vitriol, or other salts of iron, or to be smelted as other iron ores are smelted, or washed with water, whereby a valuable pigment may be produced, almost equal to the best Venetian red. At the iron furnaces at Clipper Gap, Placer County, great quantities of wood are burned in kilns to produce the charcoal required to smelt the iron; all the methylic alcohol and pyroligneous acid are allowed to go to waste. The loss of coal slack at the coal mines is very great. In other countries this material is used as a manure, or is made into blocks by the addition of coal tar or other suitable cement, and burned.

Large sums of money are expended for steam engines and fuel, where ample water power is running to waste.

Great quantities of low grade ores of lead, copper, tin, antimony, zinc, etc., are allowed to lie unworked, because they will not pay by the extravagant methods in general use; and yet low grade ores must take the place of those of higher grades, which are more difficult to find and less reliable, but which are now considered the only ores worth working.

In the deserts of California and Arizona, where water is very difficult to obtain, even for drinking, dry washing becomes a matter of the greatest importance. The following description is in reply to a letter of inquiry sent by the State Mineralogist:

You wish a description of our method of dry washing. We first find a ravine supposed to contain gold, in which we sink a hole to the bedrock; take a sample of twenty pounds of gravel from the pay streak and pan it out in a batea without water. If the result is satisfactory, we then proceed to strip the gravel from the top to within six inches of the bedrock.

After having stripped a large surface, we then carefully mine the pay streak, and sweep the bedrock clean, and screen the entire lot through a wire screen of three-eighths-inch mesh, which assists in drying and pulverizing the material. We then feed the mass into the hopper of the Wangaman gold dry washer, and remove the concentrations every fifteen minutes. At the close of the day we have three hundred to four hundred pounds of the concentrations, which we carefully run through the machine twice, and the result of the day's work is contained in about twenty pounds of concentrations, which consist principally of black sand, iron, shot, carbonate of bismuth, and gold.

The gold is separated from the other concentrations by the aid of water and quicksilver in a miner's pan.

WILLIAM K. SIME,
Phœnix, Arizona.

In Nevada advantage has lately been taken of the abundant dry sand to produce a steady power, which cannot be obtained by wind. The sand is elevated to a tank of sufficient height by an elevator of cups attached to a leather belt, set in motion by a windmill of sufficient power. The sand is run through a spout to the buckets of an overshot wheel of considerable diameter, which drives the concentrators or other machinery. The sand is returned to a vat below the elevator, and is used again and again. This apparatus is as yet an experiment, but there seems to be no reason why it should not be used (perhaps in some modified form) for concentration, where wind and dry sand are plenty, and wood and water scarce.

Too much cannot be said as to the importance of minerals other than those of gold and silver, and properly designated as *economic minerals*, which exist in California in the greatest abundance. It is a question if they are second in importance even to gold itself.

Coal, iron, salt, clay, and sulphuric acid are the foundation of manufactures. Clay, iron, and salt are known to exist in large quantities in the State. Coals, suitable for most purposes, are also abundant, and coal of a superior quality has been found at several Pacific Coast localities, which can be supplied in any quantity when wanted. Sulphur and pyrites are the foundation of sulphuric acid, which has been called *the king of acids*, for by its use all others are separated from their compounds. It is the foundation of all the great chemical manufactures. Pyrites is very abundant in the State. Sulphur is also found at several localities, but a great deal of this mineral has been imported from Sicily and Japan. Great quantities of pyrites containing a small portion of copper are imported into England and burned in extensive lead-lined chambers, for the sulphuric acid they will produce; after which they are treated for copper. What remains is largely oxide of iron, which is partly reduced to metal, and partly used in various manufactures. The amount of domestic pyrites raised in the United Kingdom in a single year has been as much as 65,916 tons, the value of which was £39,470 sterling.

The roasting of sulphurets containing gold, in the chlorination process, as practiced in California, is wasteful in the extreme; as before mentioned, not only is a notable portion of the gold lost, but all the sulphur, arsenic, and other valuable substances allowed to go to waste. These by-products should be utilized and included in the profits.

The first question asked at the Paris Exposition of 1878, when the California minerals were displayed, was, "Where are your fertilizers?" and next, "Where are your coals?"

It will be well to consider the import of these inquiries. If we do not return some equivalent to the soil, the crops will gradually become less bountiful, until a period will be reached when they will not pay to harvest. If we do not turn our attention to manufactures we cannot expect to reach a condition of great prosperity.

The question of fertilizers is one of the greatest importance to the world at large, and enormous capital is invested in their production and transportation. It is worthy of note that bone dust is somewhat largely produced in California, and is mostly, if not wholly, exported. Gypsum and marl are to be found in the State, and will eventually be utilized. Because native phosphates have not been discovered, it does not follow that they do not exist. The amount of Peruvian guano imported into England from 1844 to 1873 is estimated to be 5,500,000 tons. Mineral manures are extensively manufactured in Great Britain. In the year 1873 the yield of phosphatic nodules, or coprolites, at one locality in England, was 32,000 tons.

The amount of common sand consumed in large cities is almost incredible. The capital invested in the sand trade of New York City is estimated at two million dollars. Four thousand five hundred tons of sand, on an average, are sent to the great city daily, in boats, from the beaches of New Jersey. So it is with other minerals generally considered of little or no value, yet they are indispensable, and play an important part in the arts which confer comfort and convenience on mankind.

The following list of the most important economic minerals has been prepared to show how varied and numerous they are. If those found in California cannot immediately be made available, it does not follow that they are the less valuable. It is too often the case that those finding deposits of minerals regard them only as a source of immediate wealth, and if the mine or deposit cannot be at once sold it is abandoned as worthless. But while the failure to do this is the cause of disappointment to the individual, the information so gained is of great importance to the State, and will be taken advantage of when a demand is created by the increase of population and manufactures.

LIST OF THE MOST IMPORTANT ECONOMIC MINERALS.

Those in CAPITALS *have been found in the State.*

1. ALUM,
2. Amber,
3. ANHYDRITE,
4. ASBESTUS,
5. Bath Brick Stone,
6. BORACIC ACID,
7. BORAX.

Building Materials.

8. AGALMATOLITE, or figure stone,
9. ALABASTER,
10. ASPHALTUM,
11. BROKEN STONE, for rubble, street pavements, and macadam;
12. BASALT,
13. BITUMEN,
14. CEMENT STONE,
15. DIORITE,
16. DIATOMACEOUS EARTH,
17. FIRE STONE,
18. FREESTONE,
19. GNEISS,
20. GRANITE,
21. GREENSTONE,
22. GYPSUM,
23. HYDRAULIC LIMESTONE,
24. INDURATED VOLCANIC ASH,
25. LAVA,
26. LIMESTONES,
27. MARBLES,
28. Oolite,
29. Puzzolana,
30. SAND,
31. SANDSTONE,
32. SCHIST,
33. SERPENTINE,
34. SLATE,
35. TILE STONES,
36. Verde Antique.

37. BURR MILL STONE,
38. Carbonate of Baryta,
39. Carbonate of Strontia,
40. Carnallite,
41. Chalk,
42. CHROMIC IRON.

Clays.

43. BLUE CLAY,
44. BRICK CLAY,
45. FIRE CLAY,
46. Fuller's Earth,
47. KAOLIN,
48. Pipe Clay,
49. TERRA COTTA CLAY.

50. Cryolite,
51. Emery,
52. FELDSPAR,
53. FOSSIL GUMS.

Fuels.

54. Bituminous Shale,
55. Coal,
56. Lignite,
57. Peat,
58. Petroleum.

Gems and Semi-precious Stones.

59. Ambrite,
60. Agate,
61. Blood Stone,
62. Cat's Eye,
63. Cannel Coal,
64. Chalcedony,
65. Diamond,
66. Emerald,
67. Jasper,
68. Jet,
69. Lapiz Lazuli,
70. Malachite,
71. Obsidian,
72. Onyx,
73. Opals,
74. Ruby,
75. Sapphire,
76. Silicified Wood,
77. Topaz,
78. Turquoise.

79. Glauberite,
80. Graphite,
81. Hone Stone,
82. Iceland Spar,
83. Kainite,
84. Kieserite,
85. Lithographic Stone,
86. Mineral Waters.

Mineral Manures.

87. Coal Slack, or Dust,
88. Greensand,
89. Guano,
90. Gypsum,
91. Nitrate of Soda,
92. Ochre,
93. Phosphate of Lime.

Ores and Minerals Containing—

94. Antimony,
95. Arsenic,
96. Bismuth,
97. Bromine,
98. Cobalt,
99. Copper,
100. Chromium,
101. Iodine,
102. Iron,
103. Iridium,
104. Lead,
105. Lithium,
106. Manganese,
107. Mercury,
108. Molybdenum,
109. Nickel,
110. Palladium,
111. Platinum,
112. Potash,
113. Soda,
114. Tellurium,
115. Tin,
116. Tungsten,
117. Uranium,
118. Vanadium,
119. Zinc.

120. Polyhalite,
121. Pumice Stone,
122. Pyrites,
123. Quartz,
124. Red Chalk,
125. Rag Stones,
126. Rotten Stone,
127. Sal Ammoniac,
128. Salt,
129. Soils and Subsoils,
130. Sulphate of Baryta,
131. Sulphate of Copper,
132. Sulphate of Iron,
133. Sulphate of Potash,
134. Sulphate of Strontia,
135. Sulphur,
136. Thenardite,
137. Whetstones.

It is the province of the State Mining Bureau to seek locations of all minerals having an economic value, to learn their quality and extent, and to place specimens in the museum for study and reference. To afford an opportunity to do this to the best advantage, the State Museum should be separated from the office of State Mineralogist, and be placed in charge of a Board of Directors or Trustees. The State Mineralogist should be ready and free to start at a few hours notice to any part of the State, to investigate any new or interesting discovery, and should make himself familiar with the condition of mines and mining. He should know by personal observation the localities of all the useful minerals in the State, and should spend most of his time in the field, collecting specimens and information; the first to enrich the museum, and the latter to be published in the annual reports.

CALIFORNIA STATE MINING BUREAU.

Part 2. Third Annual Report of the State Mineralogist.

REPORT

ON THE

BORAX DEPOSITS

OF

CALIFORNIA AND NEVADA,

GIVING THE PRODUCTION, CONSUMPTION, USES, HISTORY, CHEMISTRY, AND MINERALOGY OF BORACIC ACID AND ITS COMPOUNDS, AND OTHER GENERAL INFORMATION, WITH A MAP SHOWING THE PRINCIPAL LOCALITIES IN THE TWO STATES.

By Henry G. Hanks, State Mineralogist.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1883.

To his Excellency George Stoneman, *Governor of California:*

Sir: I have the honor herewith to submit to you part second of the third annual report of the State Mineralogist of California, in compliance with Section 3 of an Act entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880.

I have the honor to be, very respectfully,

HENRY G. HANKS,
State Mineralogist.

San Francisco, June 1, 1883.

INTRODUCTION.

In this report I have endeavored, by compilation from every source at my command, joined to the results of personal observation and no inconsiderable original laboratory work, to render it so far a monograph as to afford the student, prospector, or dealer in borax, all information necessary to a general understanding of the subject.

The work is not intended to be scientific, but practical, and is specially prepared for the use of Californians interested in the production of borax, and for the public generally.

The work has been done during such time as could be spared from the more pressing demands of the Mining Bureau; for this reason it is hoped that errors and omissions will be excused.

HENRY G. HANKS.

San Francisco, June 1, 1883.

General View of the Boracic Acid Lagoons of Larderello, Province of Pisa, Italy. Copied from *Guida alle Acque Minerali D'Italia*, Guglielmo Jervis, Torino, 1868.

BORAX.

BIBORATE OF SODA, ACID METABORATE OF SODIUM (ENGLISH), BORATE DE SOUDE (FRENCH), BORAR, BORSAURE NATRON (GERMAN), BORRACE (ITALIAN), BOORAK OR BAURACH (ARABIC), SODÆ BIBORAS, PLINIAS CHRYSOCOLLA (LATIN), POUNXA, SWAGA, ZALA, TINCAL, TINKAL.

The word BORAX is of Arabic origin, and, as far as we know, appears first in the writings of Geber, an Arabian alchemist who lived in about the seventh century. The word "gibberish," anciently written *geberish*, was applied to his writings, which were filled with indefinite allusions. According to Professor Royle, the name *tincal* is derived from "*tincana*," the Sanscrit for borax.

The early history of borax is vague and uncertain. The statement by some writers, that the substance was known to the ancients, lacks confirmation. There is but little reason to believe that *chrysocolla*, literally, *gold glue*, was borax. Pliny's description shows it to have been of entirely a different nature. The name *chrysocolla* was given to borax by Agricola (*de re metallica*) because it was used in soldering gold. Agricola was a celebrated metallurgist who lived in the first part of the sixteenth century. One author (Parke's Chemical Essays, London, 1830) quotes from the writings (*Vita Caligulæ*) of Suetonius, who lived in the first century, that "the circus in his time was covered with vermilion and borax." The first borax known in Europe came from the East.

In 1732, Stephen Francis Geoffroy, a celebrated chemist, made the first analysis of borax, and was the first to notice the green flame imparted to burning alcohol by free boracic acid.

In 1748, Baron announced the discovery that borax was sedative salt and soda.

In 1772, the first authentic accounts were received in Europe as to the borax lakes of Thibet. According to Turner, "these lakes lie a few days' journey from Tezhoo Lomboo. The borax is found in masses in the mud at the bottom, beneath the stagnant water, with salt and alkali. Blanc and Pater Rovato say that these lakes lie among the mountains. The most noted (called *Necbal*) is located in the Canton of Sumbul. The water is conveyed in sluices, in which salt crystallizes. The liquor containing the borax is conducted to evaporating basins, in which the borax crystallizes out. It is impure, and has the form of six-sided crystals, sometimes colorless, at others, yellowish or green; always covered with an earthy incrustation, fatty to the touch, and with a soapy smell." Another account informs us that "the borax is dug from the margin of the lake. The crystals removed are replaced by others after the lapse of a certain time."

The following description of crude borax, as received in Europe at the time, is from the Elements of Mineralogy, Richard Kirwan; London, 1784:

Borax comes to Europe from the East Indies in a very impure state in the form of flat hexangular, irregular crystals of a dull white or greenish color, greasy to the touch; or in small crystals, as it were, cemented together by a rancid, yellowish, oily substance, intermixed with marl, gravel, and other impurities. In this state it is called *brute borax, crysocolla,* or *tincal.* It is purified by solution, filtration, and crystallization, and the crystals thus obtained are calcined to free them from greasiness, and then dissolved, filtered, and crystallized a second time. Sometimes more mineral alkali is added, as it is said that tincal contains an excess of sedative salt. It has long been thought that borax was a factitious substance, but it is now beyond all doubt that it is a natural production, since M. Grill Abrahamson sent some to Sweden in the year 1772, in a crystalline form, as dug out of the earth in the kingdom of Thibet, where it is called *pounxa my poun* and *houi poun.* As borax is purified also in the East Indies, Mr. Engestrom suspects that tincal is only the residuum of the mother liquor of the borax evaporated to dryness, and that the greasiness arises from its being mixed with buttermilk to prevent its efflorescence. It is said to have been found in Saxony in coal pits.

Early writers knew but little about borax, as will be seen from the following quotations from old works on chemistry and mineralogy:

HISTORY OF BORAX.

[From the Chemical Works of Caspar Neuman, London, 1773.]

It is commonly said that borax is prepared in the eastern countries from a green saline liquor which runs from certain hills and is received in pits lined with clay, and suffered to evaporate by the sun's heat; that a bluish mud which the liquor brings along with it is frequently stirred up, and a bituminous matter which floats on the surface taken off; that when the whole is reduced to a thick consistence some melted fat is mixed, the matter covered up with dry vegetable substances and then a thin coat of clay, and that when the salt is crystallized it is separated from the earth by a sieve.

In some countries is found a considerable quantity of a native mineral ancaline salt on the surface of the earth, sometimes tolerably pure, more commonly blended with heterogenous matters of various colors—the "*nitrum*" or "*natron*" of the ancients, the "*baurach*" of the Arabians—this alkali appears to be the same with the basis of this salt, and with the lixivial salt of kali or kelp, and some other maritime plants. It differs from the common vegetable alkalies in being milder and less acrid in taste, assuming a crystalline appearance, not deliquescing in the air, or very slowly, forming with the marine acid a perfect sea salt, with the nitrous, quadrangular nitre, and with the vitriolic, sal mirabile.

Mr. Pott received from Tranquebar, whence the greatest quantities of borax are made, a sand under the name of "*ore of borax,*" with an account that certain acrid vegetable matters were added in the preparation of borax; the ore yielded on elixation only the mineral alkali, with a little sea salt.

The mineral alkali appears from experiment to be a principal ingredient in borax. On treating borax with acids about one fourth of its weight of a peculiar saline substance called "sedative salt," is separated, and the residuum proves a combination of the alkali with the acid employed; thus when the marine acid is employed a genuine sea salt remains, when the nitrous, a quadrangular nitre, and when the vitriolic, a sal mirabile. The substance separated, joined to the mineral alkali, to the basis of sea salt, or the salt of kali, recomposes the borax again.

Thus we find borax composed of two principles—one everywhere plentiful, another which has not hitherto been obtained but from borax itself; the last in the smallest proportion. How far this peculiar substance is natural, of mineral or of vegetable origin, is wholly unknown. Borax comes from the East Indies in little crystalline masses, somewhat resembling small crystals of sal gem, mixed with earth and other impurities. Whether it is natural or artificial we have no satisfactory account; most probably it is in a great measure artificial, and the earthy matter mixed with it to make us look upon it as a fossil salt peculiar to the Indies. It is refined in Europe, but the process is also kept a secret. Some additional substances are generally supposed to be employed, the refined borax being in larger crystals than we can make this salt shoot by itself.

BORAX OF SODA.

[*From the Elements of Natural History and Chemistry, M. Fourcroy, London,* 1790.]

Borax of soda or common borax, is a neutral salt formed by the combination of the boracic acid with soda. We get this salt from the East Indies, but its history is very little known. We know not certainly whether it be a product of nature or art. The discovery of boracic acid existing in a state of solution in the waters of certain lakes in Tuscany, give us reason to think borax a product of nature. A variety of facts which we shall hereafter mention concur to show that this salt may be also formed by artificial processes as well as nitre. Borax of soda appears in commerce in three different states. In the first it is crude borax, tincal, or chrysocolla—this we get from Persia. It is in greenish masses which feel greasy, or in opaque crystals colored like green leeks, which are prismatic figures of six faces, terminating in irregular pyramids; there are even two kinds of these greenish crystals differing from each other in size. This salt is very impure, a great many extraneous substances being intermixed with it.

The second species, known by the name of *China borax*, is rather more pure than the former. It appears in the form of small plates or in masses, irregularly crystallized, and of a dirty white color. It displays the beginnings as it were of prisms and pyramids confounded together without any systematical arrangement; the surfaces of these crystals are covered with a white dust which is thought to be of an argillaceous nature.

The third species is Dutch, or refined borax; it appears in fragments of crystals transparent and tolerably pure. Pyramids with a number of faces are observed in it, but their crystallization appears to have been interrupted; its form affords a certain indication of the manner in which the Dutch purify this salt—it is by solution and crystallization. Lastly it is prepared in Paris by Messrs. Lefguillers, druggists, and their purified borax is in no way inferior in purity to the Dutch borax. Besides these four kinds of borax, M. La Pierre, apothecary in Paris, has imagined it to be formed in a mixture of soapsuds with dirty kitchen water, which a certain individual preserves in a kind of ditch, obtaining from it at the end of a certain time genuine borax, in beautiful crystals. But this fact, though first communicated to the public ten years ago, has not yet received confirmation.

We are still ignorant, therefore, in what manner borax is formed, only it seems to be produced in stagnant waters containing fat matters; some authors assure us that it is artificially composed in China by mixing in a trench, grease, clay, and dung, in alternate layers, watering this collection of matters at proper times, and leaving it untouched for several years; at the end of this time, by forming these matters into a lixivium, crude borax is obtained.

Others would persuade us that it is got out of water filtered through copper ore. M. Baumé positively asserts that the former of these processes succeeded very well with him. * * * We leave it in possession of the name of borax in order to distinguish it from genuine borate of soda, which is saturated with boracic acid. We likewise call it borax supersaturated with soda, to indicate the nature of the combination.

[*From Thompson's Chemistry*, 1818.]

BORATE OF SODA.

Of this salt there are two sub-specifics, namely: *borate of soda* and *borax*. This salt (borate of soda), which may be formed by saturating borax with boracic acid, has never been examined. Bergman informs us that about half its weight of boracic acid is necessary to saturate the borax. * * * From the experiments of Wenzel, the proportion of its constituents seem to be, acid 100, base 44, but no confidence can be put in this analysis. Berzelius attempted to ascertain its composition, but met with difficulties which he was unable to surmount.

BORAX.

This salt, the only one which has been accurately examined, is supposed to have been known to the ancients and to be the substance denominated chrysocolla by Pliny. * * * Bergman was the first who demonstrated that it has an excess of base and is therefore a sub-borate. This salt is brought from the East Indies in an impure state under the name of "*tincal*," enveloped in a kind of fatty matter, which Vauquelin has ascertained to be a soap with soda for a base. When purified in Europe it takes the name of borax. The purification was formerly performed by the Dutch and of late by the British, but the process which they follow is not known. Valmont Bomare informs us that they extract 80 parts of pure borax from 100 parts of tincal. The operations are conducted in leaden vessels, and consist chiefly in repeated solutions, filtrations, and crystallizations. Valmont Bomare suspects that they employ lime water. The difficulty in refining tincal arises from the presence of a substance resembling soap, composed of a natural fatty body which surrounds the crystals.

REFINING OF NATIVE BORAX OR TINCAL.

Tincal was first refined in Venice, whence came the name "*Venetian borax*" as a distinction from "*tincal*" or "*crude borax*." The process was at a later period introduced into Holland and France by the Leucuyer Brothers. The process was preserved as a profound secret, yet a number of descriptions were published, of which the following are quoted:

The following is the improved mode of purifying borax: the crude crystals are to be broken into small lumps and spread upon a filter lined with a lead coating, under which a piece of cloth is stretched upon a wooden frame, the lumps are piled up to the heighth of twelve inches and washed with small quantities of a caustic ley of five degrees Beaumé (Specific gravity 1.033) until the liquor comes off nearly colorless; they are then drained and put into a large copper of boiling water in such quantities that the solution stands at twenty degrees Beaumé (Specific gravity 1.160); carbonate of soda equal to twelve per cent of the borax must now be added, the mixed solution allowed to settle, and the clear liquid syphoned off into crystallizing vessels. Whenever the mother liquors get foul they must be evaporated to dryness in cast-iron pots and roasted to burn away the viscid coloring matter.

[*From Chaptal's Elements of Chemistry, 3d American Edition, Boston,* 1806.]

In order to purify borax nothing more is required than to clear it of the noxious substance which soils it and impedes its solution. Crude borax, added to a solution of mineral alkali, is more completely dissolved, and may be obtained in considerable beauty by a first crystallization, but it retains the alkali made use of; and borax purified in this manner possesses a greater portion of the alkali than in its crude state. The oily part of the borax may be destroyed by calcination. By this treatment it becomes more soluble, and may be purified in this way, but the method is attended with considerable loss, and is not so advantageous as might be imagined. The most simple method of purifying borax consists in boiling it strongly and for a long time. This solution being filtered, affords by evaporation crystals rather foul, which may be purified by a second operation similar to the foregoing. I have tried all these processes in the large way, and the latter appears to me to be the most simple.

[*From Knapp's Chemical Technology.*]

In one of these methods the impurities are removed by lime, the tincal being softened in a small quantity of cold water, and stirred about with a gradual addition of about one per cent of slacked lime. The turbid lime water is alternately poured off, and when the impurities have settled down on standing, the clear liquid is again poured upon the crystals, and this process repeated several times in this manner, the greater part of the soapy compound is removed, and what still remains is separated by dissolving the crystals in hot water, and adding about two per cent of chloride of calcium, chloride of sodium is formed, and an insoluble lime soap, which is removed by straining, and the clear liquid is evaporated to the consistence of twenty-one degrees Beaumé (=Specific gravity 1.169). The crystallization is effected in wooden vessels lined with lead, and having the form of short inverted cones. This shape is preferable, because the deposit which may form collects in the lower narrower part, and does not interfere with the crystallization.

The use of lime facilitates the clarification, but may occasion loss by the formation of an insoluble borate of lime, for which reason it cannot be very strongly recommended.

Clouet recommends the powdering of the tincal, which is next mixed with ten per cent of nitrate of soda, and calcined in a cast-iron pot. The fatty substance being thus destroyed, the calcined mass is dissolved in water, and the solution evaporated to crystallization.

ARTIFICIAL BORAX.

Crude boracic acid from Italy is principally sent to England and the United States, where a large proportion of it is manufactured into borax by combination with carbonate of soda artificially. This manufacture was commenced in England, in 1818, since which time the price of borax has steadily declined, while its uses in the arts have multiplied.

There are two varieties of borax, the octahedral, most desired in France, and the prismatic, largely made in England and America, and known as the borax of commerce.

Prismatic borax has the following composition:

Boracic acid	36.6
Soda	16.2
Water	47.2
	100.00

Chemical formula, $NaO, 2BO_3+10HO$.

Prismatic borax crystallizes in the monoclinic system. The simple forms of this system are the right prism with rhomboidal base, and the oblique rhombic prism. Natural borax is always in this form. It is said that octahedral crystals have been seen in crude tincal from China, but this statement has not been verified.

The following figures of prismatic borax crystals are from *Hauy's Traité de Mineralogie:*

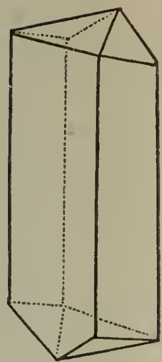

Fig. 1.

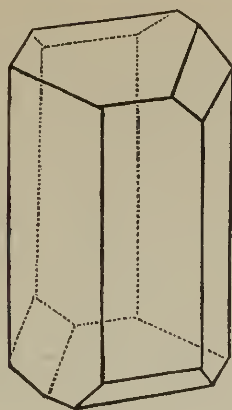

Fig. 2.

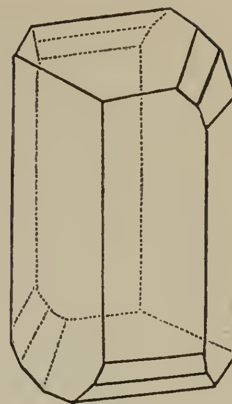

Fig. 3.

Prismatic borax is manufactured in England in the following manner: A solution of crystallized carbonate of soda is made in a lead-lined vat (*A*), figure 4, which is heated by steam from the boiler (*G*),

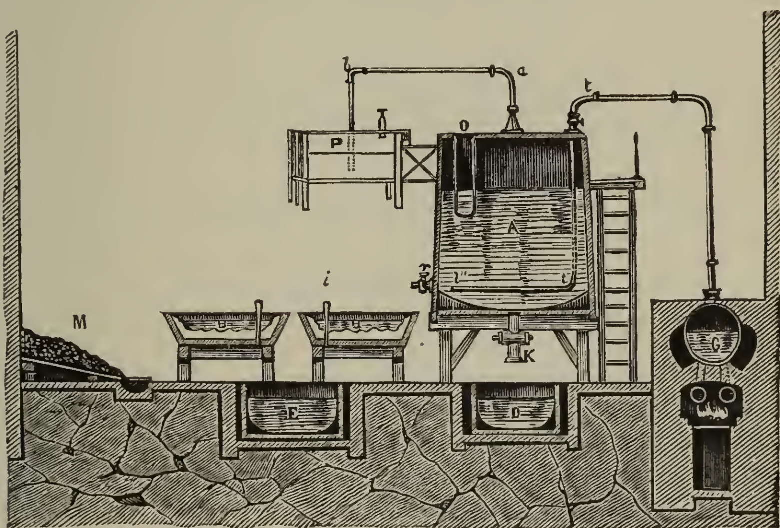

Fig. 4.

the quantity of steam required being regulated by the valve (*t*). The steam coil (*t′*) and (*t″*) is pierced with a multitude of small holes through which the steam escapes into the solution. This is called a *wet coil*, in contradistinction to a similar coil without holes, called a *dry coil*, used in evaporation, and in cases where it is undesirable to add water to the solutions. These terms will be used in all following descriptions.

When the charge of carbonate of soda is wholly dissolved, and the temperature has reached 212 Fahr., boracic acid is added portionwise, that effervescence may not cause the liquid to overflow the sides of the dissolving vat. When the required acid has been added, the vat is covered, and the temperature raised to 219–221 degrees, when the steam is shut off. The boiling solution should mark 21 to 22 degrees of Beaumé's hydrometer. If the solution should be too weak, a sufficient quantity of crude borax is thrown in; if the reverse, boiling water is added. The liquid is allowed to stand twelve hours, to settle, during which time the heat is kept up by a dry coil, through which steam is caused to flow. The clear solution is then drawn off through the cock (*r*) into the wooden lead-lined crystallizers (*B*). When the crystallization is complete, the mother liquors are drawn into the cast-iron receiver (*E*) by the openings (*i*), which are closed by a long wooden plug, shown in the engraving. The crystals are removed and drained on the inclined plane (*M*), from which the mother liquor flows into a special receiver. The impurities which have formed during the solution in the vat (*A*) are drawn off through a large cock (*K*) into a cast-iron receiver (*D*).

The vapors arising from the boiling operation contain a notable quantity of carbonate of ammonia. They are conveyed by the pipe (*b*) to a covered tank (*P*) containing a dilute solution of sulphuric acid, by which they are absorbed and retained.

The usual charge is 26 cwts. (2,912 ℔s) of carbonate of soda, dissolved in about 330 imperial gallons of water. To saturate this solution, 24 cwts. (2,688 ℔s) of crude boracic acid are required. The crystallization generally requires two to three days, the mother liquors are returned to the boiling vat until they become too foul, when they are separately concentrated, the sulphate of soda they contain crystallized out, and the remainder evaporated to dryness and sold to the glass-makers.

A process, patented by Sautter, producecs borax without the intervention of water. Thirty-eight parts of pure dry boracic acid are mixed with forty-five parts of pure dry crystallized carbonate of soda in powder. This mixture is placed in a room, heated to from 90 to 115 degrees Fahrenheit, on wooden planks, in layers of about an inch in thickness. This temperature is found sufficient to enable the boracic acid to expel the carbonic acid and excess of water from the carbonate of soda, and perfect borax, or biborate of soda, results.

Artificial borax is also extensively manufactured in France from Italian boracic acid. Nearly the whole produce of northern Italy is consumed there. The borax produced by the above processes is sufficiently pure for most commercial purposes, but the crystals are small and irregular, and there is a small excess of boracic acid. To correct these faults, a second crystallization is practiced, as follows:

The first process yields "crude artificial borax," and the latter, "refined borax of commerce."

The crude borax of the first operation is redissolved in a large lead-lined vat (*A*), fig. 5, which has a capacity of 18,000 pounds of

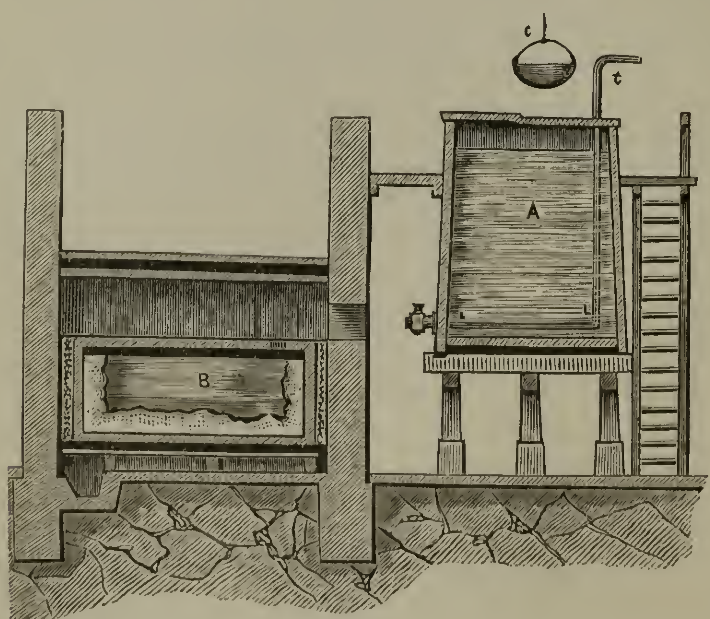

Fig. 5.

borax with the water required for its solution. The heat required is obtained in steam from a boiler, not shown, which is conveyed through the pipe (*t*) to the wet coil (*t′ t″*).

The borax is placed in the iron basket (*c*), which is suspended by a chain, and allowed to sink just below the surface of the liquid in the vat. By this plan the solution takes place more rapidly, the more concentrated solution sinking to the bottom. The basket is refilled as fast as the borax dissolves, until the whole charge has been added. To each quintal of borax (112 pounds), 8 killograms (17.63 pounds) of crystallized carbonate of soda are added, to saturate any excess of boracic acid, after which the solution is brought up to the temperature of 212 Fahr. At this heat the solution should have a density of 21 degrees Beaumé (specific gravity, 1.169); if not, it must be brought up by the addition of more crude borax, or reduced with boiling water, as the case may be.

The solution is then drawn off into the crystallizer (*B*), which has the capacity to receive the entire contents of the boiling vat. The crystallization must be slow to insure large and perfect crystals of borax. To this end the crystallizing vat must be kept warm by covering closely, and sometimes by surrounding it with spent tan bark, or straw mats. In twenty-five to thirty days the temperature has become reduced to 77 to 86 degrees Fahr., when the mother liquor is drawn off and the crystals broken down and removed by the aid of hammer and chisel.

The result is the ordinary prismatic borax of commerce. To obtain octahedral borax, the solution is made in the same way and in the same apparatus. The solution is brought up to 30 degrees Beaumé (specific gravity, 1.261), at the temperature of 212 Fahr., at which stage it is quickly run off into the crystallizer, covered and left for a time undisturbed. When the temperature has fallen to 174 Fahr., the mother liquors are drawn off, to prevent a deposit of prismatic crystals on the octahedral borax, the primitive form of which is shown in fig. 6.

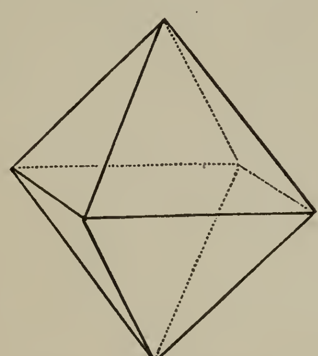

Fig. 6—Octahedral Borax.

When drawn into suitable vessels the mother liquors deposit a copious crop of prismatic borax, which may be redissolved or utilized as such.

Octahedral borax contains but five equivalents of water, and is consequently richer in the other constituents than prismatic borax. The following is the percentage composition of this salt:

Borax	69.36
Water	30.64
	100.00

The following is a translation of a portion of a letter from D. Gernez, *Professeur au Lyccé Louis Le Grand et a L'Ecole Centrale Des Arts et Manufactures*, dated Paris, September 28, 1874, in answer to inquiries relating to the manufacture of borax when but little was known on the subject in California. Professor Gernez is high authority on this subject:

The least hydrated variety is the most esteemed in commerce here. It may be obtained by the following method: Dissolve the borax in water, kept at the temperature of 100 centigrade by a jet of steam, in a wooden bucket lined with lead, until the solution be sufficiently concentrated to mark at least thirty degrees by Beaumé's areometer. Let the liquid remain at the same temperature, without disturbing, in order that it may be freed from the insoluble impurities which it contains. Pour the hot liquid into a large covered vessel in which it can cool slowly, and if you desire the crystallization to commence in a large number of points, as soon as the temperature has reached eighty degrees centigrade throw on the liquid the powder of borax, which you can obtain by roughly pounding some pieces of borax of the variety you wish to obtain.

Each grain of the crystalline powder will grow larger and give voluminous crystals which will be the only ones of their kind, while the temperature remains above sixty degrees, and which will be the only ones at a still lower temperature if the crystallizers are perfectly covered and protected from the crystalline powder of the other variety of borax.

If the crystallizers are not well covered it will be necessary to draw off the liquid at this temperature. The mother liquors will give, in cooling, the variety of borax richest in water and that which is less valued. If, on the contrary, the crystallizers be well covered, and the operation conducted on a large scale with the care that can be devoted to it on a small one in the experimental laboratory, by cooling the solution even below sixty degrees, and up to the ordinary temperature, only octahedral borax will be obtained.

None of the difficulties attending the refining of crude natural borax are met with in these operations. When the manufacture of artificial borax commenced in Europe from Italian boracic acid, the crystals were so white and pure that the consumers did not believe it to possess the strength of the dark colored article from the Dutch refineries they were in the habit of using, and this prejudice was so great that the new article did not find a ready sale. It is said that borax was sent to Amsterdam and shipped back to France as Dutch borax before it could be sold.

SOLUBILITY OF BORAX IN WATER.

Temperature.		100 parts of Water Dissolves Anhydrous Borax, Parts.	100 parts of Water Dissolves Prismatic Borax $NaO, 2\ BO_3 + 10\ HO$, Parts.
Cent.	Fah.		
0	32	1.49	2.83
10	50	2.42	4.65
20	68	4.05	7.88
30	86	6.00	11.90
40	104	8.79	17.90
50	122	12.93	27.41
60	140	18.09	40.43
70	158	24.22	57.85
80	176	31.17	76.19
90	194	40.14	116.66
100	212	55.16	201.43

Borax was accidentally discovered in California in 1856 by Dr. John A. Veatch. The following letter from that gentleman is a history of his discovery, and is quoted in full:

LETTER FROM DR. JOHN A. VEATCH TO THE BORAX COMPANY OF CALIFORNIA, JUNE 28, 1857.

Since the demonstration of the existence of boracic acid and the borates in California, in quantities sufficient for commercial purposes, a history of the discovery and a description of some of the more important localities of these useful products become matters of some interest.

I believe I was the first to detect the borates in mineral waters in this State, and perhaps, as yet, the only observer of their localities. My attention was first drawn to this subject by noticing crystals of biborate of soda in the artificially concentrated water of a mineral spring which I chanced, at the time, to be examining for other matters. This water was from one of the several springs since known as the "Tuscan Springs," and which have gained some fame, and very justly, I believe, as medicinal waters. The spot has been described by Dr. Trask under the name of the "Lick Springs," and is so designated on Britton & Rey's late map—lying in the north part of Tehama County, eight miles east of Red Bluff. The crystals alluded to were observed on the eighth day of January, 1856. Several pounds were subsequently extracted by evaporating the water to a certain degree of concentration and allowing the borax to crystallize. The pioneer specimens of this product were deposited in the Museum of the California Academy of Natural Sciences, as an evidence of the existence of a new and important link in the chain of our mineralogical productions, showing that along with the rich productions of the noble and useful metals, we have also the mineral substance so essential to their easy application to the purposes of man.

The water holding in solution so valuable a product was thought worthy of a critical analysis, and consequently at an early period the aid of a chemist of this city was invoked. The reported result, which I placed at the disposition of Dr. Trask, was thought worthy of a place in his Geological Report of that year, and appears in it. I, however, subsequently learned, to my chagrin, that the analysis was totally unreliable; but as the brilliancy of its promised results, unreal as they were, led me to further and happily successful investigations, I forgive the blundering incompetency of the chemist.

My mind being now alive to the subject, I learned upon inquiry, of other localities, which I supposed might yield the borates. One of these, near the mouth of Pit River, forty miles north of the Tuscan Springs, I had the pleasure of visiting in company with Dr. Wm. O. Ayers, in April, 1856. Specimens there obtained yielded the borate salts; and from a subsequent examination of the intermediate country several similar localities were found. The quantity was too small to be of any practical importance, but the prevalence of the salt gave encouragement to further search. A reconnoissance of the "Coast Range" of mountains, from the neighborhood of Shasta, over a length of some thirty miles toward the south, brought to light borates in the numerous salt springs abounding in that region, but only in minute quantities. These springs were found almost exclusively in the sandstone, or the magnesian limestone overlaying it, and the borates especially seemed to abound in localities bearing indications of volcanic disturbance. Thus a kind of guide was obtained in the prosecution of further explorations. I began to entertain hopes of finding larger streams with stronger impregnations, or accumulations of the borates, in salt lagoons said to exist in Colusa County, where the sandstone formation was largely developed, the adjacent foothills presenting volcanic features. Hunters told tales of mineral springs of sulphurous and bitter waters; of lakes of soda, and alkaline plains, white with efflorescent matters in that region. Not being in a situation immediately to visit these inviting localities I had, for the time, to content myself with pointing out to hunters and others occasionally passing through that country such appearances as I wished particularly to be noted. Their reports, together with specimens sometimes furnished, were all corroborative of the correctness of my theory. Col. Joel Lewis, of Sacramento City, who occasionally visited the Coast Range on hunting excursions, and to whom I explained the object of my search, and who, though not a scientific man, is an intelligent observer, had the kindness to look in his perigrinations for certain indications. He subsequently informed me by letter that he had met with an Irishman, living in Bear Valley, who had found a "lake of borax," as it was pronounced by an Englishman who lived with the Irishman, and who had been at one time employed in a borax manufactory in England, and therefore assumed to speak knowingly on the subject. He also informed me in the same letter that a Major Vanbibber, of Antelope Valley, had discovered large quantities of nitre in the same neighborhood. These glowing reports led me to hasten the excursion I had so long contemplated. In a personal interview with the Colonel he told me of an enormous mass of a white pulverulent substance he had himself observed near the margin of Clear Lake, of the nature of which he was ignorant. Mr. Charles Fairfax, who was with the Colonel at the time, stated to me that a small rivulet running at the base of the white hillock was an intensely impregnated mineral water, totally undrinkable, as he had accidentally discovered by attempting to slake his thirst with it. From the meager information gathered from these gentlemen I was led to hope the "hill of white powder," as they termed it, might prove to be borate of lime. I determined to satisfy myself by a personal examination at once, and I finally induced Col. Lewis to act as my guide, by furnishing him with a horse and paying expenses. It was some time in the early part of September, of last year (1856), that he and I left Sacramento for the localities that had so much excited my hopes. At the town of Colusa, which we reached by steamer, horses were obtained, and we proceeded in a westerly direction across the Sacramento Valley to the foothills of the coast mountains, a distance of about twenty-five miles. That portion of the plain skirting the hills gave unmistakable evidence of a heavy charge of mineral salts, and the exceedingly contorted and interrupted state of the hill strata enabled me at once to predict the presence of the beloved borates, which chemical trial on some efflorescent matter taken from a ravine proved to be the case in a slight degree. At this point we entered "Fresh Water Cañon," which cuts the hills and forms a passway into Antelope and Bear Valleys. Here I received information from a settler, of a hot sulphur spring a few miles south of Bear Valley on one of the trails leading to Clear Lake. This spring we succeeded in finding on the following day. It was with no small pleasure that I observed the outcropping magnesian limestone in the hills surrounding the valley of the springs. The strong smell of sulphuretted hydrogen and the appearance of a whitish efflorescence on the rocks manifested, even at a distance, almost the certainty of finding the mineral I sought. The indications were not deceptive. The efflorescence proved to be boracic acid in part, while the hot sulphurous water held borate of soda in solution, together with chlorides and sulphates.

There are three hot springs at this place and several cold ones, all alike strongly impregnated with common salt and borax. The quantity of water yielded, in the aggregate, is about one hundred gallons per minute, the hot and cold springs yielding about equal quantities. The temperature of the hot water is 200° Fahr., and that of the cold 60° Fahr. The same phenomenon occurs here that is observed at the Tuscan Springs, viz.: free boracic acid in the efflorescence on the margin of the springs, while the water itself shows a decided alkaline reaction. A careful examination proves that the efflorescent matters come directly from the water of the springs, taken up by capillary attraction of the soil and evaporated by the air. The singular fact may be accounted for by the decomposition of the borates by sulphuric acid generated by atmospheric action on the sulphur in which the soil abounds; or the same decomposition may be produced by the hydrosulphuric acid passing up in gaseous form from the laboratory Nature has established beneath. The same action doubtless takes place in the water; but the boracic acid set free is at once taken up by the excess of alkaline matter while in the efflorescence; no fresh supply of alkali offering, the acid remains in its free state when once displaced by more powerful acids.

These springs seem to be identical in the character of their waters with the Tuscan Springs, and therefore doubtless possess the same extraordinary medicinal virtues.

As a source of borax these springs could be made available. But as the owners of this locality possess others of superior richness, it is not likely to be even called on to yield its mineral treasures. The situation is a pleasant and romantic one, and might be made a valuable watering place. The distance from the town of Colusa is thirty-five miles, over mostly a smooth and pleasant road. From Clear Lake it is eighteen miles, and over a rather rough country. The Indian name of the place is Co-no-to-tok, a generic word having reference to the white appearance of the ground. Mr. Archibald Peachy located a three hundred and twenty acre school land warrant on this place on behalf of the borax company.

After satisfying myself with the examination of this interesting spot, we proceeded at once to Clear Lake, noting nothing of interest save a "soda spring," the water being impregnated to a remarkable degree with carbonic acid gas, about eight miles from the lake. A chemical test also detected boracic acid in small quantity. The following day we reached the "hill of white powder," the goal of our hopes, on the margin of Clear Lake. This "white powder hill" proved an illustration of how little the recollections of mere casual observers are to be depended upon. The hill, in place of consisting of materials in a state of disintegration, so as to admit of being "shoveled up," as my friends supposed, proved to be a concrete volcanic mass, bleached white by sulphurous fumes, and looking at a little distance like a huge mass of slaked lime, which the unattentive observer might readily suppose to be "a hill of white powder." The hope of a treasure, in the form of borate of lime, vanished forever!

The road had been rather toilsome, the weather excessively hot, and my guide not very well, and as he had gone the full length of the contemplated journey and felt somewhat disgusted at the result so far, and had nothing more to draw his attention in this direction, he proposed to return at once by way of the Irishman's "borax lake" and Van Bibber's nitre placer. This was agreed upon. So, collecting a few specimens of efflorescent matter from the ground and filling a bottle with water in the ravine, I closed the examination of the "hill of white powder." The ravine I afterwards called the "boracic acid ravine," and the white hill is now called the "sulphur bank." Of these I shall have occasion to speak hereafter.

Before leaving the neighborhood, I determined, however, to know something more of its surroundings. I learned, upon inquiry of Mr. Hawkins, who lives near the spot, that a place not far off known by the name of "Alkali Lake," presented a rather peculiar appearance. Hawkins consented to act as my guide. After traveling a short distance and clambering to the narrow edge of an almost precipitous mountain ridge, we looked down the opposite slope, equally steep, on a small muddy lake, that sent up, even to our elevated position, no pleasant perfumes. Thus, on one of the hottest days September ever produced, without a breath of air to dilute the exquisite scent exhaled from two hundred acres of fragrant mud, of an untold depth, I slid down the mountain side into "Alkali Lake," waded knee deep into its soapy margin, and filled a bottle with the most diabolical watery compound this side of the Dead Sea. Gathering a few specimens of the matter incrusting the shore, I hastened to escape from a spot very far from being attractive at the time, but which I have since learned to have no prejudice against. Of this place I shall have occasion to say more.

On my return to Hawkins', who had the kindness to entertain me with the genuine hospitality of a frontiersman, I looked to my last specimens, and found encouraging results in the partial chemical examination I was able to give them.

I now again placed myself under the guidance of my friend Lewis, and we started for the Irishman's house in Bear Valley. We found the owner of the "borax lake," but the borax had evaporated with the water, and left nothing but common salt tinged of a beautiful bluish red color, which I suppose had given the notion that it was something out of the usual way. It was the only specimen of salt I remember to have seen in the Coast Range that contained no boracic acid in any form; it was guiltless of even a trace.

The next step was to examine the nitre region. Major Van Bibber, the reputed discoverer, being a grandson of Daniel Boone, ought to possess, one would suppose, an hereditary knowledge of one of the essential constituents of gunpowder; and as Colonel Lewis had shown me a specimen of very fine pure nitre, which he said the Major had given him, I rather expected to find a "few more left." This, however, was rather worse than the "borax lake" disappointment. The Major had absolutely forgotten where the place was, and whether there were any more specimens than those he gave Lewis. The Major, I believe, must really have forgotten, for, upon subsequent examination, the specimens proved to be refined saltpetre, that undoubtedly came from some shop or drug store. There was certainly a mistake about its origin; but I felt amply repaid for a hard day's ride in spending a night under the hospitable roof of a direct descendant of the renowned "backwoodsman of Kentucky." I observed near the Major's house, a small salt pond. Some salt crystals I picked up had the peculiar beveled angles indicating the presence of borax. The quantity was inconsiderable. Thus ended my first expedition to Clear Lake. We here set our faces direct for Colusa, as there seemed nothing more to be seen, and as I had engaged the horses we rode at rather a high per diem, I felt anxious to terminate the trip. From Colusa my guide returned to Sacramento, and I to Red Bluff. From there I came again to San Francisco for the purpose of testing my specimens more critically than I was able to do in the country. The minutiæ of the above trips may not interest the company, but I have personal reasons for setting forth *all the facts exactly as they occurred.*

Convinced of the richness of my "alkali lake" specimens, it remained to be seen whether the quantity was sufficient to justify the hope of making it available for practical purposes. A further and more strict examination was necessary. I felt, too, the propriety of a thorough exploration betwixt the Bluff and Clear Lake, and thence to the Bay of San Francisco, thus rendering continuous the reconnoissance from Pit River to the last named point, a distance, in a direct line, of two hundred miles. After a hard struggle for the funds requisite, I returned to Red Bluff, and from thence, in company with my son, commenced a pretty thorough examination of the Coast Range and the adjoining edge of the Sacramento Valley.

Nothing of much importance presented itself until reaching a saline district, about eighty miles south of Red Bluff. It is on one of the branches of Stony Creek. Valuable salt springs exist here. The waters contain the borates in minute quantities, and one spring was remarkable for the enormous proportion of iodine salts held in solution. In our slow onward progress borax now and again manifested itself, but as it had grown familiar I no longer went into ecstacies over a mere trace. I still treated, however, the slightest indications with due deference and noted their localities.

In due time, I again reached the "white hill." The disgust of the first disappointment had worn off and I felt disposed to reëxamine the locality rather more critically. I now discovered, for the first time, that the "white hill" was mostly a mass of sulphur fused by volcanic heat. The external crust, composed of sulphur mixed with sand and earthy impurities, formed a concrete covering of a whitish appearance, hiding the true nature of the mass beneath. On breaking the crust, numerous fissures and small cavities lined with sulphur crystals of great beauty were brought to light. Through the fissures, which seemed to communicate with the depth below, hot aqueous vapors and sulphurous fumes constantly escaped. The fused mass, covering many acres and exhibiting a bluff front some forty feet high, is exceedingly compact and ponderous in structure, of various shades, from yellow to almost black. It seems to be very pure sulphur. The quantity is enormous and at no distant day may be made available.

From the "sulphur bank" I again turned my attention to the ravine. The water, as I had before ascertained, was strongly impregnated with boracic acid in a free state. The stream is small, yielding only about three gallons per minute, and is soon lost in the sandy soil, in its progress toward the margin of the lake. From the porous nature of the ground surrounding the spring, and saturated with the same kind of acid water, it is probable a large quantity escapes without making its appearance on the surface. The soil for some yards on either side of the ravine is covered to the depth of an inch or two with boracic acid in Summer. Sulphuretted hydrogen escapes in continued bubbles through the water—a feature common to all the borax localities I have yet found; in some places, however, the carburetted takes the place of the sulphuretted hydrogen. The head of this ravine is about three hundred yards from the margin of Clear Lake, winding round the base of the "sulphur bank," receiving some small springs in its course, which seem to have their origin beneath the sulphur. The flat land bordering the lake, some eight acres in extent, through which the ravine runs, shows a strong impregnation of boracic acid in its soil. The point where the ravine enters the lake is marked by a large quantity of water of a boiling temperature, issuing through the sand a little within the margin of the lake. This percolation of hot water covers an area of one hundred and fifty by seventy-five feet. This fact I observed on my second visit, but not until the third or fourth visit did I ascertain that the water contained a considerable quantity of borax, along with an excess of boracic acid. From a gallon I obtained four hundred and eighty-eight grains of solid matter, consisting of borax, boracic acid, and a small portion of silicious and other earthy impurities. On digging to a slight depth, just outside the lake, the hot water burst up and ran off freely. From one of these places a stream issued of sixty gallons per minute. I have estimated the entire quantity at three hundred gallons per minute, and feel very confident of being largely within bounds. The stream seems to come from the direction of the sulphur bank, and it would probably be easy to intercept it before it enters the lake by digging a little above high water mark. It may be well to note here that the difference betwixt high and low water marks in Clear Lake is never more than three feet.

The enormous amount of borax these springs are capable of yielding would equal half the quantity of that article consumed both in Europe and America. The large quantity of water in which it is dissolved would, of course, involve the necessity of extensive works for evaporation. Graduation, as a cheap and effective method of evaporation, would be exceedingly applicable here, from the continued prevalence of winds throughout the entire year. These winds, blowing almost unceasingly from the west, form a peculiar feature of the country about Clear Lake. There is nothing to hinder the manufacture of many millions of pounds of borax per annum, at a cost but little beyond that of producing salt by graduation. Fuel, for final evaporation, could be had in any quantities from the extensive oak forest in the immediate vicinity.

With these observations I dismiss this locality; adding, however, that Mr. Joseph G. Baldwin located this with a 480-acre school land warrant, for the benefit of the borax company.

Having wandered from the story of my second visit to the "sulphur bank," and blended it with observations made in several subsequent examinations, I turn now to my second visit to "Alkali Lake," or "Lake Kaysa," as the Indians call it. I need only to say, however, that on this occasion I became fully satisfied of the great value of the locality, the extent of which has only recently been developed. I observed that the lake itself contained but little water, but that wells, dug anywhere near its margin, immediately filled with the same kind of water; the conclusion, therefore, was that an almost inexhaustible supply was obtainable. I learned, too, that what seemed to be mud at the margin, and shelving off and covering the entire bottom to the depth of some feet, was a peculiar, jelly-like substance of a soapy feel and smell. This matter I found to be so rich in borax that I supposed it might be advantageously used for the extraction of the mineral. Thus satisfied of the value of the lake, I little thought that within a few yards of me lay an additional value in the form of millions of pounds of pure borax crystals hidden by the jelly-like substance I was then contemplating. This important fact was not observed until some six months afterwards.

This locality is by far the most important I have yet discovered. It is situated in the angle of two prongs into which Clear Lake is divided at its eastern extremity. The elevated hill land that fills the angle separates into two sharp ridges, each following its division of the lake, and leaving a valley between them of a triangular shape, near the apex of which lies "Alkali Lake." Clear Lake is, therefore, on two sides of it, distant to the north about a mile, and to the south about half the distance. The open part of the triangular plain looks to the east, and expands into an extensive valley, from which it is cut off partially by a low volcanic ridge, running across from one hill to the other, and thus inclosing the triangle. This ridge is composed of huge masses of rock, resembling pumice stone, which floats like cork in the water. A thin stratum of ashy-looking soil, scattered over with obsidian fragments, cover the ridge, and affords root to a stunted growth of manzanita shrubs.

The whole neighborhood bears marks of comparatively recent volcanic action. Indeed, the action has not ceased yet, entirely. Hot sulphurous fumes issue from several places on the edge of the ridge just named, on the side next the Alkali Lake.

The "lake," as it is called, is rather a marsh than a lake, in Summer. In Winter it covers some two hundred acres with about three feet depth of water. In the dry portion of the year it shrinks to some fifty or sixty acres, with a depth of only a few inches. The "soapy matter" covers the entire extent with a depth of nearly four feet, the upper part for a foot in depth being in a state of semi-fluidity, the lower having the consistency of stiff mortar. Beneath this is a rather tenacious blue clay, the depth of which is as yet undetermined. It has been penetrated fifteen feet with but little change in appearance. Probably beneath this lies the great fountain of intensely charged mineral water forming the lake, the supply of which must come from below, as there are no visible springs running into it. It has no outlet, and never goes entirely dry. A six-inch auger bored into this clay, at a depth of eight feet, struck a stream of water yielding eight gallons per minute, accompanied with a jet of carburetted hydrogen gas. This water was nearly as highly charged with solid matter as that of the lake in its highest Summer concentration; the proportion of borax to the other substances being greater. The soapy or gelatinous matter, however, presents the greatest feature of attraction, being filled with the prismatic crystals of pure borax. They vary from a microscopic size up to the weight of several ounces. These crystals are semi-transparent, of a whitish or yellowish color. The form is an oblique, rhomboidal prism with replaced edges and truncated angles. In some cases the edges are beveled, and in others the unmodified hexahedral prism exists. Beneath the gelatinous matter, on the surface of the blue clay, and from six to eighteen inches in it, crystals of a similar form, but of a much larger size, are found. They weigh from an ounce up to a pound, and seem to have been formed under different circumstances from the other crystals. My first impression was they had been formed in the upper stratum, and sinking by their own gravity had found their present position. An examination proves, however, that they were formed where they lie, as particles of the blue clay are found inclosed in their centers, which could not have been the case had the upper crystals been their nuclei, for no blue matter is ever found in them.

It is much to be regretted that explorations have not yet been made beyond the depth of this blue clay stratum. Many important results may be anticipated from such examination. The great source of supply might be reached, and, although the water might not contain more borax, the alkaline matters so redundant at the surface would probably be less, and the difficulty of separation be consequently decreased. From the constant escape of inflammable gases over the whole extent of the lake, there is nothing improbable in the supposition that boring to a moderate depth would give exit to a quantity sufficient to answer as fuel for evaporating the water. The same thing occurs in some portions of the United States—gas being used as fuel for extensive salt works. I hope to be excused for theorizing a little as it is intended to point to practical results. I will now confine myself to facts.

The first inquiry of practical interest relates to the quantity of borax already formed. On this subject I cannot speak with perfect confidence. The quantity is very considerable, but I do not look on the experiments heretofore made to test this matter as conclusive. The area covered by the crystalline deposit is not co-extensive with that of the lake, but has been found over a space of about twenty acres in the examination made so far. It will probably be found to cover the same space the water does at the driest season—say fifty acres. The crystals are not indiscriminately dispersed through the soapy or gelatinous matter, but lie in strata of various thickness, from half an inch to six inches, parted by intervening layers of the soapy matter, and varying from one to six in number. In passing over them in a boat a stick thrust down sometimes requires great force to drive it through, while in other spots it enters with little resistance, proving a great irregularity in these crystalline strata. The lower or blue clay stratum of large crystals consists of but one layer of variable thickness. Two experiments alone have been made to ascertain the quantity in a given space. Dr. Ayres sunk a coffer dam three feet square at a point he supposed to be of medium richness, and extracted therefrom one hundred and sixty-three pounds of crystals. I subsequently put down a coffer of the same dimensions at a point I supposed to be the poorest, as no crystals could be felt by thrusting down a stick, and obtained one hundred and one pounds. Taking the mean between these as a datum we should have 638,880 pounds as the product of one acre. The large crystals form about ten per cent of the whole.

Whether these crystals when removed would be replaced by others, so as to afford an annual supply, is a question of great practical importance. But as experiment alone can settle this, we will suppose, as the safer ground, that the crystals would not be replaced. We will assume, too, that the lake water is exhaustible and dependence must be placed on wells—is it likely a sufficient supply can be thus obtained? I think there is no hesitancy in answering this query in the affirmative. The well already dug yields eight gallons per minute, equaling 4,204,800 gallons per annum. The water holds in solution 12,480 grains of solid matters to the gallon, or two pounds and ninety-six grains. Assuming twenty per cent of the matters to be borax, which I believe to be not above the truth, the yield would be largely over a million and a half of pounds per annum from this one well. A few such wells would supply borax enough for the world.

To remove the borax from the complex solution, of which it forms the least soluble portion, crystallization presents the easiest and most effectual mode. To obtain this result, the excess of water must be expelled. Graduation would be scarcely applicable to water concentrated as this and boiling would have to be resorted to. The excess of water would be about five pounds to the gallon, thus leaving three pounds of water to hold two pounds of matter in solution for crystallizing. If it be required to operate on a given quantity of water in a given time, say one gallon per minute, a boiling surface of ten square feet would be necessary. Five pounds of water per minute would equal 7,200 pounds per twenty-four hours, requiring the consumption of 2,400 pounds of oak wood, or about three quarters of a cord. The solid matter would equal 2,880 pounds held in solution by 540 gallons of water. A crystallizing tank eight by ten feet, and one foot in depth, would be wanted to contain it. Should the borax equal only twenty per cent of the other matters, we should have 575 pounds as the result of the evaporation of one gallon per minute. Fuel is abundant and would cost two dollars and fifty cents per cord. In this calculation we have the elements of cost of manufacturing borax. The entire expense would probably not reach one cent per pound. The heaviest item of the whole would be the land transportation to the point of shipment—a distance of fifty-five miles. This would cost about one and a half cents. We might, upon the whole, safely calculate three cents as covering all expense upon the article laid down in the City of San Francisco.

A very valuable collateral product, iodine—with the compounds of which the water seems to be exceedingly rich—could be made a source of revenue with but little additional expense. With regard to the quantity of iodine, I cannot speak positively, not having isolated the product; but from the brilliant reaction with the qualitative tests, there can be no doubt of its being great. Should this article be manufactured largely, the sulphuric acid required might be made on the spot, from the products of the "sulphur bank," one and a half miles distant. With this, I leave Alkali Lake. I would state, that I located this place in my own name for the company.

There is yet another important borax locality in the same vicinity, resembling much the foregoing in its more prominent features. It consists of a pond of water of about twenty acres. The bottom is covered with the same soap-like substance, but seems to contain no crystals. The water contains less solid matter in solution, but the percentage of borax is greater in proportion to the other substances than in the Alkali Lake. The borax separates readily by crystallization, and forms about thirty-three per cent of the whole matter. Like the foregoing, this pond has no outlet and no visible source of supply, yet it is said never to be dry, although the water is never more than three feet deep. It would, perhaps, be a profitable source of borax, if the millions of pounds the before described localities are capable of yielding, be not enough to supply the demand. It is in the midst of a magnificent grove of pines and oaks. The place was taken up by Mr. Archibald Peachy for the borax company, by the location of a 320-acre school land warrant.

The borates are also known to exist in other localities betwixt Clear Lake and Napa City. In Siegler Valley there is a hot spring in the waters of which I detected borates of strontia and other borate salts. Near Napa there is a borate spring, and one in Suisun Valley, near the marble quarry. None of these places are important.

The foregoing are the only borax localities known in the northern part of this State, and I feel confident there are no others in that quarter that can ever compete with the inexhaustible stores of "Alkali Lake" and the "Hot Springs."

I had expected to find something worthy of attention at or in the neighborhood of the Geysers. But there was no trace of borates in the hot waters of those springs, nor anywhere in the surrounding district. The geological features of the country were so different from that where I had heretofore found the borates, that I was able to predict, as soon as I saw it, that nothing of the kind existed.

In a hasty reconnoissance of the great Tulare Valley, I found traces, but nothing more, of these substances. I have reasons for doubting the existence of any large quantities in that region. That portion of the valley bordering on the Coast Range might be worth examining further. It is there, if anywhere, valuable deposits may be looked for.

There are probably as many as three districts in the lower part of the State, presenting the borates. One or more valuable localities may probably be found among them. As I expect soon to visit that portion of the State, I hope to be able at an early day to present to my friends of the borax company any valuable information I may there gain touching their interests.

Truly and respectfully yours,

JOHN A. VEATCH, M. D.

Borax was for a time successfully manufactured at the borax lakes in Lake County, under the superintendence of Dr. William O. Ayers, until the discovery of the vast fields of Nevada, followed by a speculative over-production, which, while it gave to the world an abundance of that useful, but before rare and costly mineral product, ruined nearly every person or company engaged in its exploration, manufacture, or sale. The history of the California borax lakes has been lately given to the world in an able article by Dr. Ayers in the Popular Science Monthly, a portion of which is quoted below:

BORAX IN AMERICA.

[By W. O. Ayers, M. D.]

Borax Lake and Hachinhama [pronounced *Hah'-chin-ha'-ma*), both lie in the immediate vicinity of Clear Lake, about eighty miles north of San Francisco.

Borax Lake is a shallow pool intensely of alkaline water, without inlet or outlet, and of course its extent depends on its reception of rain water. After an exceptionally wet season it has a length of perhaps a mile and a half, with a depth of eight or ten feet; after an exceptionally dry season, on the contrary, it shows sometimes no water, the muddy bottom being covered with saline incrustations. When it has a length of three fourths of a mile, with a depth of four feet, being perhaps its average condition, the water holds in solution 18.75 grains of solid matter to the ounce—.039 of its own weight. This consists of salts of soda, in the following proportions:

Sodium carbonate	61.8
Sodium chloride	20.4
Sodium biborate	17.8
	100.0

But this alkaline water, exceedingly rich as it is in borax, constitutes only a trifling part of the commercial value of the lake. In fact, it has never been turned to account at all in the manufacture of borax, though such use of it is entirely practicable, as the statements to be presently made in relation to Hachinhama will show. The muddy bottom of the lake was found, immediately on its discovery in 1856, to contain borax in crystals, in quantities most astonishing.

These crystals, being tested by various workers in iron and steel, were pronounced equal to the very best of refined borax. They are, in fact, pure biborate of soda, without any other impurities than the mud mechanically entangled with them in the process of crystallization. They correspond to the native borax of other localities, designated as *tincal*, but yet are decidedly distinct from it. In fact, no such crystals as those of Borax Lake have ever been found in any other locality, and there are several points in connection with their mode of formation, and even their very existence, which are by no means easy of comprehension, as we shall see.

Although the discovery was made, as already stated, in 1856, no practical development of the lake was begun until 1864. From this time it was pressed vigorously until 1868, when it ceased, not from failure of the supply, but simply from mismanagement of the work. The crystals were certainly less abundant at the last than in the earlier workings, but the lake still held and doubtless holds now an amount running to many millions of pounds, if it be not in truth practically inexhaustible.

Their abundance was such, and the yield was so great, that within the period specified the lake had revolutionized the borax trade of the United States; in fact, it had accomplished that work before the close of the year 1864. The annual importations since 1855, the earliest date at which the Congressional reports enable us to trace them, had varied from $143,218 to $217,944. In 1864 they were suddenly reduced to $8,984, a result due entirely to the working of Borax Lake.

A statement of the manner in which the crude crystals were removed and utilized will bring to our notice the strange peculiarities of their nature, origin, and mode of crystallization.

The mud which constitutes the bottom of the lake is a smooth, even, plastic clay, of unknown depth. It has been bored through thirty feet without showing change in its structure. The upper portion, for four and a half to five feet, holds unnumbered crystals; at that depth they suddenly and abruptly cease. Abundant explorations demonstrated that none were to be found any lower, and the daily working came to recognize the fact as established. The mud below that was saturated with the salts of soda, such as held by the water of the lake, but no distinct crystals existed.

The crystals of borax, in the upper portion, were removed by means of coffer dams. Each dam consisted of a box, without top or bottom, four feet square and six feet deep, made of thin boiler iron, suitably stiffened with surrounding bands of heavier iron. These dams, suspended above the water, between large pontoons or floats, were allowed to drop suddenly, whereupon their force of descent drove the sharp lower edge down through the soft mud and into that which was sufficiently firm and tenacious to resist the impact, and to render thus the iron walls of each a true coffer dam, from which the entire contents could be easily removed.

The water was first pumped or bailed out, till it became too thick to flow easily, and the remaining mud was lifted in tubs, in true mining style, and thrown into large troughs, where, being subjected to constant agitation in streams of the lake water, it was washed away, the borax being retained by its superior gravity.

No crystals were found until from twelve to fifteen inches in depth of the most fluid mud had passed away. The mud then began to feel "gritty," as the workmen expressed it, the "grit" consisting of multitudes of most exquisitely perfect minute crystals of borax. These crystals, like all those in the lake, were lying loose, detached from each other, attached to nothing by the base, and consequently perfect at both ends. It is not meant by this that every crystal was absolutely complete in every angle, but that they all had the tendency to the theoretical type, symmetrical at each end (a form which in artificial crystallization we scarcely ever reach, except by accident), and that many of them showed the type in full perfection, such as no model could excel or equal.

With every descending inch through the mud their size increased; the "grit" soon became "sand;" in a few inches farther crystals were very manifest to the eye, and shortly a "layer" was reached. It is true that in some places no "layers" occurred, the crystals being scattered at random through the mud. But in most instances when from twenty-four to thirty inches of surface mud had been removed, and the crystals had attained a length of one fourth to one half an inch, one or more "layers" would be found within the four feet square of the coffer dam. In these "layers" the crystals were so closely packed as to have no mud intermingled with them; they were nearly as clean as though recently washed in clear water, lying closely stowed and loose, like pebbles on a beach. A "layer" might be one to four inches thick and two feet, more or less, in length, surrounded on all sides by mud which held only scattered crystals, without any such richness as its developed pocket.

Going deeper, the crystals became constantly larger, though less numerous, as the mud grew more dense, until a stratum was reached which was designated "blue clay." In the mud immediately above the blue clay, crystals from one to two inches long were very common, though many of the smaller ones were still intermingled. Here a change in the crystals showed itself, full as well marked as the change in the bed in which they lay. The small crystals were not present; they had never been formed as in the mud above. Instead of them lay imbedded scattered crystals, few in number, but of great size, and having commonly a family look by which they could be recognized. Few of them were as small as two inches in length, and not unfrequently those weighing a pound each were obtained, being perhaps five to seven inches long, by two to four inches wide.

They lay imbedded in the clay, which was so firm that they could be picked out singly, each leaving the sharp mold which it had formed during its slow process of crystallization. They were all within a little more than a foot of the surface of the blue clay, many explorations showing that it was useless to seek for them at a greater depth.

Of the abundance of the crystals within the portion of the lake occupied by them, a space of about forty acres, some idea may be formed from the fact that nine hundred pounds have been gathered from one dam, four feet square. And this by no means represents their full amount, as all the smaller crystals were washed back again into the lake in the process of their separation. At the same time it was remarkably true that the yield was very uneven. In what was known as "rich ground" barren spots constantly occurred, and often almost the entire yield of a dam came from one side or one corner, perhaps only a third or a fourth part of the full area.

The crystals thus obtained had a decidedly green color. The figure introduced is given for the purpose of conveying an idea of the size which the green crystals sometimes attained. It is not an exaggeration. I have seen many which weighed individually as much as the one here delineated. Their proportions were very erratic, but always conforming to the one type.

They were entirely free from the tenacious coating incident to the tincal of other localities; were readily and perfectly soluble in hot water, and in the process of refining by solution and recrystallization yielded their full weight of transparent borax of the finest quality, less merely the weight of the mud which had been mechanically entangled with them during their growth in a muddy menstrum. The green color disappeared in the refining, not being found either in the deposited mud or the new crystals.

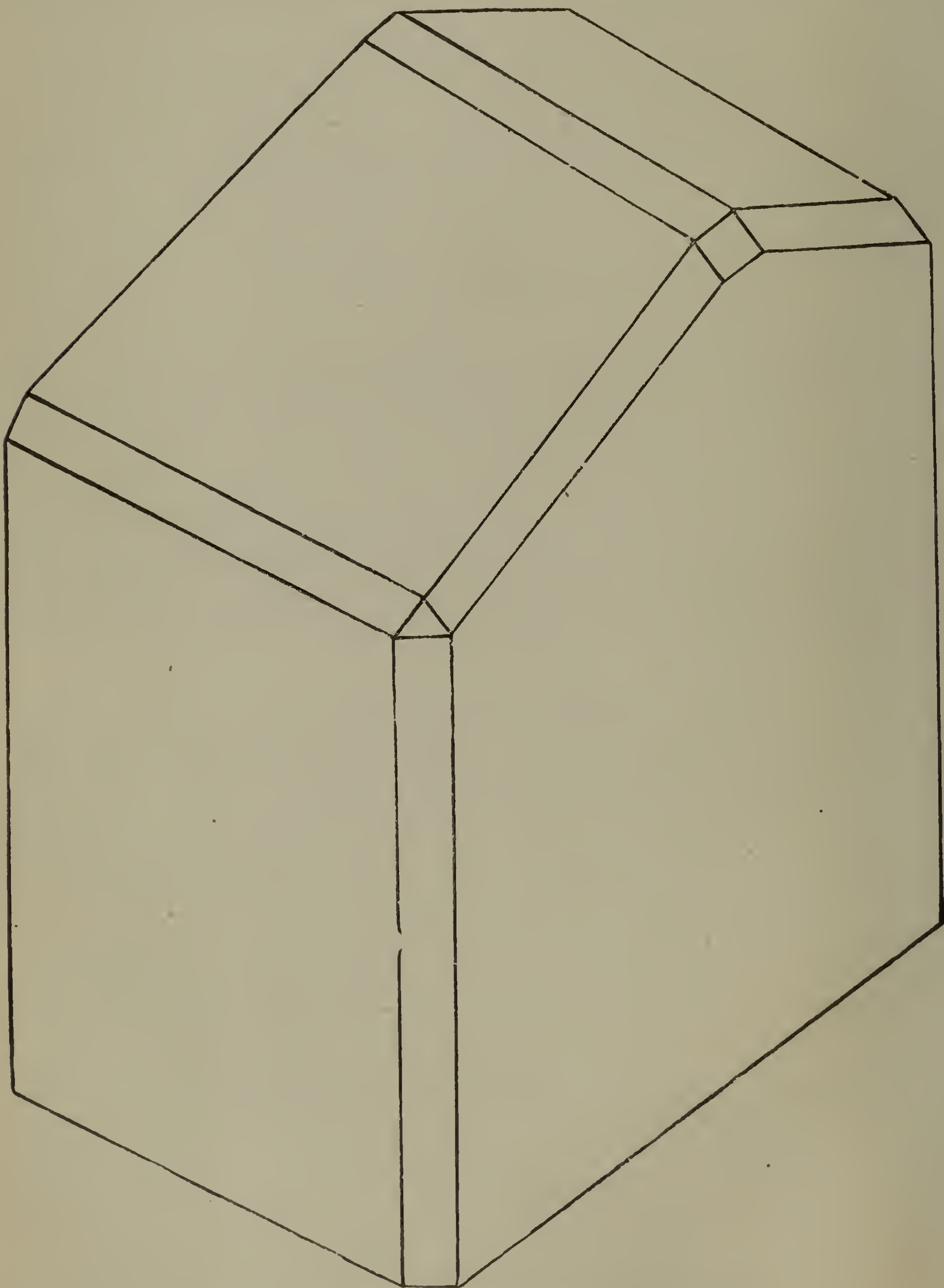

Fig. 7—Crystal of Native Borax from Borax Lake. Natural size.

We are prepared now to look at the origin of these salts as held in solution or in crystalline form. If, in a basin of water, more or less shallow, containing a plastic soda-mud in the form of chloride and carbonate, deriving its carbonic acid from one source and its chlorine from another during its deposition, or, subsequently, fissures were opened in the subjacent strata, allowing the escape of a limited amount of jets of boracic acid from beneath in vapor, we should have all the conditions required to account for the formation of the borax in the midst of the two more loosely combined salts.

Thus far our way is plain. But whence came the enormous deposition of the green crystals of Borax Lake, their isolation and segregation in perfect crystallized integrity, and their continued preservation; while at the same time, in a solution almost identical in chemical composition, as we shall see, at Hachinhama, and in which often the proportion of borax to a given quantity of water becomes greater, no such crystals exist?

In most instances of salts crystallizing from a solution, the crystals attach themselves by a base to whatever material is adjacent, and when numerous they form a crystalline mass, from which the summits only of the crystals project—a crystal perfect at both extremities and sides not being common. And in Borax Lake itself, whenever the water has evaporated to such a degree in a dry season as to form a deposit from excess of strength, it has been an amorphous crust of carbonate, chloride, and borate, with no perfect crystals of either.

But the green crystals are isolated, and in thousands of instances are absolutely perfect, ends and sides. The large ones of the blue clay lie, as we have seen, each in its own mold. The smaller ones above lie often in layers, inches in thickness, hundreds of crystals heaped together as distinct from each other and as separate as pebbles on a beach.

Still, again, comes the strange fact that these crystals have been lying, how long we cannot say, but almost certainly for very, very many years (for there is not the slightest evidence to lead us to believe that they are of recent formation), in a solution which makes no approach to saturation, and to whose influence as a solvent they seem totally indifferent.

The water of Borax Lake, when it has a depth in its main extent of five feet, which it often has for very many months, and perhaps years in succession, holds in solution about half an ounce of borax to the gallon. During this interval, for four or five months of the Summer season, its temperature is at no time lower than 55° to 60° Fahr. But water at that temperature dissolves a little over eight ounces of borax to the gallon. How, then, can the green crystals remain in such a liquid so long without being destroyed?

It may be supposed that the carbonate and chloride, in the complex mixture, render the hold of the borax so slight that, because of their presence, it is ready to separate. In reply to this suggestion comes the statement of the fact that when the same water is concentrated by evaporation to a specific gravity of 12° Beaumé, in which state it holds in solution six ounces of borax to the gallon, no tendency is manifest to the formation of even a single crystal.

Again, it has been suggested that, lying in a muddy menstrum, the movement of particles is so far arrested as to prevent diffusion, the stratum of water immediately surrounding each crystal becoming saturated and remaining unchanged. But this does not in the least account for the commencement of crystallization, which so far as we can judge, must have been in an exceedingly weak solution. Nor does it perhaps seem possible that such complete seclusion from ascending and descending currents could in any way be secured. The Winter rains pour in quite fierce torrents of drainage water from all sides, often rendering the entire lake decidedly turbid, and of course causing more or less of commotion in every part. And in addition to this is the diffusion of particles, caused by the changes of temperature throughout the year.

In whatever light, therefore, the question is viewed, it is not free from difficulties. And yet at the same time it is but right to recall the fact that these green crystals are in their nature tincal, though such tincal as has never been found elsewhere, and that the crystals of tincal are perhaps in other localities formed subject to the same conditions as here prevail.

We turn now to Hachinhama, the other locality mentioned. This is on the southern side of Clear Lake, about four miles west of Borax Lake, which it closely resembles in its features, though much smaller, being an oval lagoon about four hundred yards in length. We have, as there, a sheet of clear alkaline water, with a bottom of soft, plastic mud. This mud has been bored to about the same depth as in the explorations at Borax Lake, without its lower limit being reached.

The evidences that the alkaline pool occupies the space of an extinct crater, are more manifest here than at Borax Lake, as the inclosing walls still remain, though abraded on their northern extremity, while on the south they rise abruptly to the great mountain summit of Conoktai.

The water of Hachinhama holds in solution the salts of soda in the following proportions:

Sodium carbonate	75.4
Sodium chloride	08.3
Sodium biborate	16.3
Total	100.0

The mud throughout its entire depth is richly stored with the same salts, but without any development whatever of crystallization of any kind.

After the cessation of work at Borax Lake, in 1868, attention was turned to the resources of Hachinhama. Of course, the style of working must be totally different, for here was no borax ready formed, no green crystals needing simply solution and recrystallization. All that was available was a sheet of water, holding the salts above recorded. The problem, then, was to separate in purity the borax—the only one of sufficient value to be worth the effort—and leave the others.

Borax being the least soluble of the three salts, and at the same time much more soluble in hot water than in cold, it was argued that, were the water of Hachinhama sufficiently concentrated by boiling and then allowed to cool slowly, the borax would crystallize out, leaving the carbonate and chloride in solution.

This is correct in theory, and in laboratory practice the results were entirely satisfactory, but in working large quantities the case was found very different. Concentrated to 20° B., a crop of crystals was deposited which were pure borax, but they were scarcely more than fifty per cent of the borax originally held by the lye thus formed. When, now, this mother liquor was still further concentrated, no more pure borax separated, but a combined mass of borate and carbonate.

And here was manifested another feature. The amount of borax available depended very largely on the bulk of the solution in which it was allowed to cool. Very small quantities were of course useless in practical working, though the crop from them was satisfactory. Patiently continued trials showed that pans of two or three gallons gave, economically, the best results. But even here the borax clung so closely to the carbonate as to occasion much difficulty, until the plan was devised of crystallizing them together, and then washing away the carbonate by means of its greater solubility.

This was the plan adopted, and by its use about eighty per cent of the borax originally contained in the Hachinhama water, as pumped into the evaporating pans, was secured. The extent of the works may be estimated from the fact that about 4,000 of the pans mentioned were in daily use.

But the unassisted lake water was not long used. Hachinhama, from its shallowness, becomes nearly or quite dry at the close of each Summer. As it dries away, the exposed mud is thickly covered with the salts deposited. These were carefully removed for use. The surface thus cleared of its salts began at once to renew its coating, the deposit being speedily replaced by capillary attraction from the stores beneath. In a week, or perhaps more, the surface was ready for sweeping again. The second crop was abundant, it was replaced by a third, and by others in succession, till the advent of the rains (never occurring in that climate till October, or perhaps November) put a stop to their formation.

This process was repeated each year during the occupation of Hachinhama, and, when the lake filled in turn with the Winter rains, the alkaline water bore the same degree of strength consecutively, showing that the stores of supply in the mud beneath gave no evidence of exhaustion.

The salts thus gathered were used by lixiviation to strengthen the lake water in the evaporating pans, and thus increase the yield of borax.

The work of refining the borax thus obtained differed in nothing from that employed with the green crystals of Borax Lake—hot solution and crystallization in lead-lined tanks. Hachinhama borax, as placed in the market, was of a grade of excellence never surpassed.

The works were conducted in this manner until the Spring of 1872, when a change was introduced in consequence of the discovery that immense deposits of borates existed in Nevada. It was determined to utilize the borate of lime, in the form of ulexite, for the conversion into borax of the carbonate of soda held in the water of Hachinhama.

The ulexite was brought by carloads from the deserts east of the Sierra Nevada to San Francisco, and thence to Clear Lake, and a great increase in the borax yield of Hachinhama was the result. The process adopted was to saturate, with the ulexite, the boiling lye from the lixiviating tanks, before it had acquired sufficient strength to crystallize on cooling. A double decomposition was thus accomplished, resulting in a thick, milky-looking mixture which was an intensified solution of borax, rendered turbid by the insoluble carbonate of lime, this latter speedily settling and leaving the clear borax liquor for concentration and crystallization.

Practically, however, this solution was never pure, for here came in again the same fact which had been demonstrated in the first workings at Hachinhama, that the bulk of the liquid in which the action took place had much to do with the chemical union accomplished. In laboratory experiments the work was perfect, and a boiling heat of only a few minutes formed the full theoretical amount of borax demanded; yet, when dealing with large quantities, this proved impracticable. Although violent boiling was long continued, even for hours, analysis of the lye showed that a certain proportion of the carbonate of soda still remained untouched by the boracic acid, and that, too, when the ulexite employed was in excess of the amount which careful analysis showed was sufficient to saturate the carbonate of soda present. And this excess was a necessity, and the daily working came to recognize it and to act accordingly, for, when the even theoretical quantity only was used, a much larger portion of soda remained untouched.

The operations at Hachinhama continued vigorously till 1874, by which time the enormous supply of borax brought into the market from Nevada had reduced the price to so low a point that further production became impossible. Hachinhama supplied all the American borax made from the cessation of work at Borax Lake in 1868 till 1873, and the two localities afforded, between 1864 and 1874, all that was ever made in California. The yield of Hachinhama, during the last two years of its running, was something over five thousand cases of one hundred and twelve pounds each. * * *

These lakes now lie idle for the reason before stated, namely, over production and a glutted market, and to an unfortunate mistake which was made in 1868, when the volume of water was largely increased by the flow of an artesian well, sunk for experimental purposes, which could not be controlled. This made it unprofitable to evaporate the waters of the lake, and crystals were partly, if not wholly redissolved. This property will keep, and the day will probably come, when with cheaper labor and more favorable conditions, it will again yield its valuable products to the world. The waters will then, probably, be concentrated by the graduation process so extensively employed in the manufacture of salt from dilute solutions. In November, 1866, J. Arthur Phillips, of London, made a report to the company, in which he estimates the borax in the lake at twenty-seven thousand one hundred and twenty tons. These figures are based somewhat on conjecture, and may be in excess of reality; but Professor Phillips is not a man to be easily misled, or to any great extent mistaken. The calculation was made as stated in the following quotation from the above mentioned report:

The total extent of the muddy deposit considerably exceeds three hundred acres, and if we assume that, of this area, only one hundred acres, or that portion now worked for borax crystals, is alone sufficiently rich to pay the expenses of treatment, we shall arrive at the following figures:

One hundred acres are equivalent to 484,000 square yards, and if the mud be worked to the depth of only three and one half feet, this represents about 565,000 cubic yards; or, allowing a cubic yard to weigh a ton of 2,240 pounds, which is a very low estimate, the total weight of one hundred acres of mud, in its wet state, will be 565,000 tons. If we now assume that the mud extracted from the lake contains sixty per cent of water, this will correspond to 226,000 tons of dry mud, containing, according to the mean of the analyses of Professor Oxland and Mr. Moore, 18.29 per cent of borax; but if, in practice, only twelve per cent of borax be obtained, this will represent 27,120 tons of crystallized salt.

If the estimates of Prof. Phillips seem large, what must be thought of the calculations of the company, who assume the available borax on the property to be 684,800 tons, or more than twenty-seven times the entire yield of the Pacific Coast since the discovery of borax in 1856. The estimate of Prof. Phillips is based on the assay of a single sample of the average mud taken from an artesian well at the depth of sixty feet, and the additional amount outside the central 100 acres, also on the result of a single assay of mud. The grand total is made up as below copied from the report of the company published in San Francisco in 1866. It might be considered out of place were I to express my opinion of such estimates, and specially so as I have never made a personal examination of the locality.

It is one thing to calculate the quantity present upon such shallow data, but quite another to prove the estimate correct. There can be no doubt, however, as to there being a large quantity of workable borax in these lakes, which will in future be extracted to the advantage of the owners and the State.

ESTIMATES BY THE COMPANY.

In the central 100 acres, above the level of five and one half feet	107,800 tons.
In the outer 200 acres, above the same level	119,600 tons.
In the central 100 acres, below five and one half feet	228,600 tons.
In the outer 200 acres, below five and one half feet	228,800 tons.
An aggregate of prismatic borax of	684,800 tons.

Now, it must not be forgotten that each analysis was of mud taken from many different points in the lake, and not from one point only, nor from the central 100 acres of ground *previously worked over* by the company; that the mean of these analyses, calculated for anhydrous mud=22.86 per cent, but estimated at *eighteen per cent* only. For the outer 200 acres gave 12.85 per cent, but estimated at *ten per cent* only—and these calculations are based on the supposition that the deposit *near the shore* represents the average richness of the whole, which we know to be otherwise, for that taken from within 300 feet of the shore gave 32.63 per cent, instead of *ten per cent;* the mean of the two gives 22.74 per cent, and, estimated at these figures, would have given 260,000 tons, instead of 119.600. So that, had we taken as the basis of our estimates the *full value* of the analyses and other tests, we should have had an aggregate of 964,600 tons of borax, instead of 684,800 tons. In these estimates, no account has been taken of the large amount of borax held in solution in the water of the lake, nor of the 200 acres, or more, extending to the eastward, and once forming a part of the lake itself.

Such exaggerated statements reappear in statistical works and reports to the discredit of the State, as, for example, in the fourth volume of the United States Reports of the International Exhibition at Philadelphia, folio 176, it will be found stated that the earth in and around the well known borax lake of California yields from twenty to forty per cent of this salt, "and the material exposed to view is estimated to contain *ten millions of tons of borax.*"

The borax produced at the California borax lakes was remarkably pure, and free from those vexatious substances mentioned elsewhere, which interfere with the crystallization. The following analysis is given to verify this statement. I have, also, had considerable personal experience with the products of these lakes at the time they were being worked:

ANALYSIS OF CALIFORNIA REFINED BORAX, FROM SAMPLES FORWARDED BY THAYER AND WAKELEE, OF SAN FRANCISCO, TO HENRY KENDAL AND SONS, LONDON.

ANALYTICAL LABORATORY, SURGEON'S HALL,
EDINBURGH, October 4, 1865.

Refined Borax.

Biborate of soda, pure and dry	54.39
Water of crystallization	45.55
Insoluble matter	traces
Sulphate of soda, dry	0.06
Chloride of sodium	traces
	100.00

The above refined borax is of first class quality, and is commercially pure.

There are a number of other localities in California at which borax is being produced at the present time. San Bernardino and Inyo Counties are rich in this mineral. A number of extensive fields are known.

In 1874, one hundred and fifty quarter sections of borax lands were entered in the United States Land Office at Independence, Inyo County, California. Many of them were soon abandoned, as they were not found rich enough to work with profit.

The property of the San Bernardino Borax Mining Company is the most extensively worked, and has already yielded largely. This property lies in township 30 south, range 38 east, Mount Diablo base and meridian. It is in San Bernardino County, near the line of Inyo. The discovery was made February 14, 1873, by Dennis Searles and E. M. Skillings. In April, 1874, J. W. Searles and J. D. Creigh, as company representatives, made application to the same Land Office for four United States patents covering 160 acres of the borax lands. The company was not incorporated until January 1, 1878.

There are three modes of obtaining borax at this locality: the first by evaporating water charged with borax; second, by lixiviation of crude material, mostly sand; and by working quite extensive deposits of tincal.

Crude borax is found on the surface mixed with sand in a light granular form. No ulexite has been observed at this locality. Experience has shown that it requires thirteen tons of crude material to produce one ton of borax. This is equal to 7.69 per cent. Tincal in a very pure state in crystalline masses is found under the surface of the ground at the depth of from three inches to a foot, mixed with salt and thenardite, so pure that it is called ice, which it certainly resembles. The deposit is not regular, but is described as being "spotted."

The production of borax commenced in 1874. The product readily brings one cent per pound more in the market than Nevada borax. There are no difficulties in the crystallization, and it is equal in excellence to the best borax of Lake County.

The excessive heat and dryness of the climate cause the crystals to part with a portion of water. In Summer 100 parts are equivalent to 105 parts of theoretical borax when they reach London. The borax is hauled in wagons to Mohave station, over a dreary and sterile sandy desert, so devoid of water that a supply must be hauled in other wagons to supply the animals and men with drink. The time consumed in the trip and return is ten days.

The borax is obtained from the crude material in the following manner: There are five steam boiling tanks, each with a capacity of 7,000 gallons; the impure, natural borax is shoveled into the boiling tanks, and the soluble matter dissolved by heat communicated through a wet steam coil, of one and a quarter inch iron pipe. The boiling tanks are made of three-inch Oregon cedar, seven feet deep, and ten and a half feet square on the bottom. They are not lined. When the solutions are brought to the proper strength (16° to 30° Beaumé, according to the character of the material), they are drawn off, while still hot, into crystallizing vats lined with galvanized iron. There are thirty of these vats, which are cylindrical. The borax taken from the crystallizers, after the first operation, is called "*concentrated*," and is not wholly pure. While the solutions are cooling, the mud is sluiced out of the boiling tanks, after which they are again filled, and the operation goes on continuously.

In due time the crystals are taken from the crystallizers and returned to the boiling tanks, a portion of which are kept for this special work. Clean water is pumped in and the steam turned on. When solution is effected, and the liquor has the density of 18°, the liquors are run into square crystallizers, which are also lined with galvanized iron, and the solution made to cool slowly, although the climate is so warm that outside protection is unnecessary. Every precaution is observed that there may be no disturbance during crystallization. The result is "*refined borax*" of a very superior quality.

The mother liquors are returned to the boiling tanks, and used again and again for the first solutions, until they become so foul as to yield crystals of foreign salts, when they are allowed to go to waste. Of the square crystallizers there are nine, six of which are forty-eight feet long, and three, thirty feet long. All of them are four feet deep and four and a half feet wide.

All liquors are returned to the boiling tanks by a steam syphon pump. Water is brought seven and a half miles in inch and a quarter iron pipes for the steam boilers and for drinking; but water for the solutions is derived from fourteen wells, each of which is fifty-five feet deep. These wells are artesian, the water rising three feet above the surface. The entire steam power is derived from one steam boiler, 42 inches in diameter, with 32 flues. Covers to the boiling tanks are made of Oregon pine. There is a rough wooden building over the boiling tanks, but none over any other of the works. The solutions are drawn off by means of an iron pipe, which passes up through the bottom of the tank, and is connected with a shorter length, to which it is joined by a common elbow, loose enough to turn easily. The jointed pipe is lowered gradually at the proper time, drawing the hot solution from the surface. This is a simple and convenient appliance, the use of which greatly facilitates the operation. It is very much like one to be described in the mention of Teel's Marsh works in Nevada.

A large evaporating trough of wood has lately been added to the plant, which is lined with galvanized iron, and is used in connection with open cuts or trenches in the ground, to concentrate by the sun's heat the foul mother liquors. This trough or tank has a capacity of 10,000 gallons. In it the last portion of borax crystallizes out.

Fifty men and thirty-five animals are employed at these works. All the fuel is obtained from the marsh, being wholly sage brush and grease wood, which grow near by in great abundance. This fuel is gathered in wagons and thrown into the furnace under the boiler with pitchforks. In this work fourteen mules are continually employed.

The lake bed from which the borax is obtained has an area twelve miles long by eight miles wide. An English company, under the management of Mr. T. Dodge, commenced operations near the same locality in May, 1876.

Borates have been found elsewhere in San Bernardino County, although but little is known as to their extent and character. The following newspaper notices are given, as containing about all that is known regarding the new discoveries:

BORAX MARSHES.

[Calico Print.]

Besides the large borax fields owned by the Searles Brothers and William T. Coleman & Co., in Death Valley, there are also other localities in this county that have been taken up by other parties. About eight miles southeast of Hawley's Station, at Coyote Holes, there is a marsh of two or three hundred acres surrounded with an immense deposit of borax. The marsh is chiefly a large deposit of carbonate of soda. The borax is of a fine quality, and known as cotton-ball borax. It is necessary, in order to reduce it to a crystallized form, to mix with it carbonate of soda, which nature has, it seems, placed there for that purpose. The best part of this marsh has been located by William Curry, E. J. Miller, and O. H. Baker. The property has been bonded by the James Brothers for $12,000. Borax is worth thirteen cents a pound in San Francisco, and it is not very expensive to reduce the borax, so that the parties interested are likely to make some money out of the enterprise. Daggett Station is the nearest shipping point, which, fortunately, is not as far from this borax deposit as it is from others.

BORAX PATCH.

[San Bernardino Times.]

A 1,200-acre borax patch has been located near Black's ranch, on the line of the Southern Pacific Railroad to the north of us, by a number of prominent gentlemen. The borax is said to be found there from three inches to two feet in thickness, and in almost unlimited quantities. This industry promises to be one of more than ordinary importance to our county.

Mr. S. Heydenfeldt, Jr., lately made a visit to Calico District on business. He sent a sample of a white chalky substance to the State Mining Bureau, for examination, which proved to be "priceite," identical with that found at the original locality of that mineral at Chetco, Curry County, Oregon, and described elsewhere. Soon after the Calico Print published the following notice, which is at present the extent of our knowledge on the subject. The specimens may be seen in the State Museum:

BORAX MINES.

There is considerable excitement in Calico District over recent discoveries of borax deposits within a couple of miles of the town of Calico. The principal deposits are in the eastern part of the district and comprise an area of four or five miles square. Several sales were made last week of borax claims, amounting to $4,250, and since then, lands hitherto supposed to be worthless have been located in twenty acre claims as borax deposits. Several claims located for silver, but considered poor, have been prospected for borax, and in some places with favorable results. It is claimed by some that there are large deposits of borax in the district, some of it of fine quality. In one place there is a small mountain of it; and if all the deposits located are in reality borax of a marketable quality, the immense quantity of it cannot fail to be a source of great wealth to this district.

Mr. Robertson, one of the firm of Wm. T. Coleman & Co., has purchased the borax deposits mentioned above, and will soon set men to work on the property.

KERN COUNTY.

Borate of lime (ulexite) was discovered at Desert Springs, called also Cane Springs, in Kern County, February 15, 1873, from whence considerable quantity has been extracted. The dry lake in which the borates are found is situated in T. 30 south, R. 38 east, Mt. Diablo base and meridian. The following is an extract from the Los Angeles Express, published about the time of the discovery:

THE BORAX DISCOVERY IN KERN COUNTY.

As already noted in the Express a very extensive borate deposit has been discovered in Kern County, at a distance of about 120 miles from this city. Specimens of the borate have been on exhibition in this office, and are seen to be of a pure and valuable quality.

The deposits discovered by H. J. Lent lie about 120 miles from this city, about three miles off the Owens River road, near Harry Ball's station, at Desert Springs. They were found about four weeks ago. They extend from Ball's house to the end of the marsh, about nine miles long and three wide. The borate is found in spots of two, three, or four acres, more or less. Messrs. Lent, Ball & Chapman's claims contain probably 500,000 tons of borate of lime; of course, they are the best deposits that could be found at the time. Mr. Lent, however, has no doubt that other deposits, equally valuable, though not so great in extent, will be taken up.

Mr. Lent has been in charge of the borax works at Columbus, Nevada, which, with those at Fish Lake, in the same locality, are the only borax deposits hitherto known on this coast, excepting those of Lake County. He thinks that these new discoveries contain a much larger percentage of boracic acid than the deposits at Columbus. He believes that there is room for the employment of a thousand men in these fields and those at Slate Range, sixty miles distant. He has refined some of the borate, and has made an excellent quality of borax, a specimen of which we have. He is having made at Harper & Dalton's some vats and other rude contrivances for the reduction of the borate, which he intends to put upon the ground, and, after reducing the borate there, ship borax to this city, for transhipment. He also thinks of putting up works there for refining, though he believes it would perhaps be cheaper and better to have a refinery here.

We learn that borate deposits have also been found at Slate Range, about sixty miles distant from the original discovery. A considerable number of locators are moving to the borax fields from Inyo and Kern Counties, and several parties have gone from Los Angeles County. Messrs. Austin and Baker, of this city, are by this time upon the ground, and will undoubtedly secure valuable locations.

INYO COUNTY.

Borax was discovered in Death Valley, Inyo County, in 1873, but owing to climatic peculiarities of the region, distance from railroad communication, pre-occupation, and over-production at other more accessible localities, no active operations were attempted until the present year.

Relocation was stimulated by the near approach of the Carson and Colorado Railroad, which is now finished to San Carlos, on Owens

River, will soon be extended to the Colorado River, and will pass within a few miles of the borax deposits, although the final route is still uncertain.

Death Valley, in which these deposits lie, is one of the most remarkable geographical localities on the face of the earth. The following is compiled from notes furnished by Dr. S. G. George, who visited the valley in 1860, William T. Henderson, 1860, Hugh McCormack, 1861, R. R. Hawkins, 1882, I. Daunet, 1883, and others. The subject is one of such peculiar interest that somewhat lengthy descriptions will not be deemed irrelevant.

DEATH VALLEY

Takes its name from the circumstance of a company of emigrants entering it on their way from Salt Lake to California in the year 1850. Very little was known then of the passes through the mountains, and this party made the fatal mistake of attempting a more direct pass than the well known emigrant road. They little knew the dreadful experience they were destined to make, or the sufferings they were to endure. The valley was to them a *cul de sac*, a region wholly unexplored. While seeking an outlet, they experienced dangers and difficulties wholly unexpected, and almost insurmountable. Finding it impossible to take their wagons over the mountains, they abandoned them, and while some of the party climbed the rugged and roadless passes, others, seeking water, miserably perished. Those who escaped, in relating the horrors of the journey, told romantic stories of mines, of gold and silver, all generally exaggerated, but which have induced others to visit the locality in search of the mythical mines described. Bennett, one of the emigrants, drank at a running stream of clear water, on the pebbly bottom of which he said he saw lumps of glittering gold ; an unlikely story, for gold is seldom if ever seen under such circumstances. Another said he found a piece of white metal which he took with him, not knowing its nature or value until months after, while at Los Angeles, he required a new gunsight, and delivering the metal to the gunsmith with an order, was informed that it was pure silver.

This story, more absurd, if possible, than the first, has caused a number of parties to visit and explore Death Valley in search of the "gunsight lead," which has never been found. While these expeditions have generally ended in disappointment, they have led to a knowledge of the country, the discovery of mines of antimony, silver, and gold, of unknown value, and now of not less important borax fields. The discovery of Coso, Slate Range, Owen's Valley, Panamint, Argus, Telescope, Calico, and other mining districts, are the results of these expeditions, as will be seen by the notes of prospectors quoted in this paper.

Death Valley proper lies within the area bounded by the meridians 116° 30′ and 117° west longitude, and parallels 35° 45′ and 36° 30′ north latitude. Its direction is nearly north and south, length from Furnace Creek south, 40 miles; average width, 8 miles. At the south end, branch valleys extend southeastwardly and southwestwardly; the former is known as "Amargosa Valley," "Bed of Amargosa River," or "Amargosa Wash." It extends 25 miles or more. The latter is "Long Valley," extending 12 miles, and ending in a cañon.

One portion of Death Valley sinks below the level of the sea. The line of greatest depression lies along the eastern side of the valley, and extends about 15 miles, north and south. The lowest sink is a little east of south from Furnace Creek, and distant 19 miles. It is 110 feet below the sea level. It lies 5 miles eastwardly from Bennett's Wells, and 4 miles due east from the Eagle Borax Mining Company's ground, which is itself 69 feet below the surface level of the ocean. Telescope Peak, only 15 miles west, rises 10,937 feet above sea level, and 11,047 feet above the lowest depression in Death Valley. Its summit is seldom free from snow.

To the eastward rise the Funeral range of mountains, the highest summits of which are 6,754 feet in altitude, and to the west, the Panamint range, of which Telescope is the highest peak. The mountain summits are about 30 miles apart. Beyond the Panamint range lies Panamint Valley, 45 miles long and 10 wide, having a direction nearly parallel with Death Valley, but more elevated; the average altitude being about 1,400 feet. The town of Panamint, in Surprise Cañon, has an altitude of 6,600 feet.

The formation about Death Valley seems, by descriptions given, to be generally stratified, sedimentary rocks, sandstones, and limestones containing fossils. There are in the State Museum, specimens of blue limestone weathered and worn by drifting sands, in which there are undetermined fossil corals.

Very little is known of the geology of this region. The portion below the sea level has but a small area as compared with the immense inclined planes which dip toward it from all directions. If water was abundant, there would be a lake at this point, but the great heat, dry atmosphere, and the loose nature of the soil combine to prevent any accumulation of water.

The Amargosa River heads in Nevada and some of its branches in the Amargosa Mountains. It flows southerly 100 miles or more, when sweeping in a great curve around the base or southern ends of the mountain chains, it returns northerly to Death Valley, which is called also "the sink of the Amargosa." While there are channels produced by floods of great extent, and a cañon cut by the river at some former period, never within the knowledge of man has any water been known to flow into Death Valley through the old river bed, known as the Amargosa Wash. At what period these deep channels were cut is unknown.

Mr. McCormack thinks that the sink of the Mohave, at a certain time not very remote, has overflowed and emptied an excess of water into Death Valley. The Mohave River heads in San Bernardino County.

Near Bennett's Wells Mr. McCormack observed a hill of stratified rocks, yellow and blue, in such strong contrast as to suggest the name "*Curious Butte*," and near by he found flexible sandstone—*Itacolumnite*.

Furnace Creek was discovered and named by Dr. French's party in 1860. Its mouth is fifty-six miles due east from the eastern shore of Owen's Great Lake. It was so named from the discovery by the party of ruined lead furnaces, in which the Mormons had extracted lead from galena to make bullets to be used against the United States troops in 1857. Water flows all the year round, the average quantity being one hundred miners' inches. The water is good for drinking, but is always warm. It has been stated that during some seasons the temperature of the water is 120°. The stream flows for a few miles from the mouth of the cañon, and sinks in the sand, to be seen no more. The altitude at the entrance of the cañon is 2,874 feet. Quite a settlement in the interest of the borax company has sprung up, which has been named *Greenland.* Garden vegetables, melons, alfalfa, and other plants have been successfully cultivated by dint of almost constant irrigation.

The climate of Death Valley is most distressing to the human body. While in Winter it is quite pleasant, in Summer it is almost unbearable. The dryness of the air is so excessive that moisture is withdrawn from the body faster than it can be supplied through the system. From this cause frequent cases of death have occurred when water was plenty, but which could not be drank fast enough to supply the drain caused by the desiccative power of the dry hot air.

The atmosphere presents many peculiar features, among others, causing a feeling of lassitude and weariness and an intense thirst upon very slight exertion. Many of those who have been for a month or more residents of the valley complain of an affection of the eyes, which become sore and weak. A very short walk will cause great thirst, and at times even the raising of the canteen to the mouth seems an exertion. Mr. Hawkins, who furnishes this information, says: "It has been stated that birds, attempting to fly across the valley, drop dead. While the writer cannot verify this by occular proof, he has picked up, at different times, two little birds, a mile or so from water, whose bodies were still quite warm, having evidently but just dropped dead. But little or no vegetation can be found a short distance from water, excepting sage brush. Near the creeks only grass, willow, and mesquit bushes grow." During the visit of Mr. Hawkins, in May and June, 1882, almost every afternoon a burning wind, fierce and powerful, sprang up, blowing articles of considerable weight some distance, and hurling the coarse, hot sand with such force as to lacerate the face when exposed, the men being frequently obliged to wear veils and goggles.

The heat was severe, the thermometer averaging from 95° to 100° Fahrenheit in the shade; and in July the average was 100° and over, being often above 120° in the shade. The stones and cement became so hot by ten o'clock A. M. that work was suspended until late in the afternoon, and at night the men frequently rolled themselves in thoroughly wet blankets in their endeavors to keep cool.

Each year the bodies of one or more men and their animals have been found, who have perished from want of water or from climatic effects; a few months before Mr. Hawkins' visit the bodies of two men were found who had attempted to cross the valley; they had food and water still remaining. The climate, in this case, was the cause. Still later, the body of a man was found in Furnace Creek Cañon, only a mile from water. Two men have died this Fall from the effects of the heat; in fact, all who live there are obliged to leave every few months to recuperate.

The following from the Inyo Independent, of recent date, is of the same general tenor:

DEATH VALLEY.

The country around Death Valley, and lying in the triangle formed by the eastern line of Inyo and the northern line of San Bernardino Counties, is perhaps the least explored region of the United States. The intrepid prospector, though suspecting the presence of great mineral wealth and ever eager to open new districts, hesitates to penetrate its center, for once lost within its embrace, without water, the poise of the mind swerved by fever, phantasy unseating reason, bewildered, he wanders without aim; his blazing eye beholding heaven in the snowy outline of the distant Sierras, in the flame of the desert he falls to die! Thus, many in these desolate ranges have lain them down in despair, forever, uncoffined and unknown. It is not a rare event for prospectors to find the bleaching skeletons of those who in early years dared these treacherous solitudes. The whitened bones of the dead seem a natural part of these landscapes—dead men lying on the slopes of dead mountains. Such a skeleton was lately discovered in the Coso range, where it had, by the evidence of papers also found, lain undisturbed for ten long years. What a picture for the imagination is that of the dead lying in these solitudes at the blast of the last trumpet starting again to life—alone!

The experience of Mr. I. Daunet has been still more remarkable. On one occasion he was driven to the necessity of killing his animals and drinking their blood as a substitute for water. Two of his party died from the effect of the heat and want of water. He has just returned from the works of the Eagle Borax Company, of which he is President, finding it impossible to endure the heat.

The terrors of Death Valley seem to arise from three causes: the great heat, which is owing to the physical characteristics described; excessive dryness of the atmosphere; and scarcity of water. From the fact that the valley is surrounded by mountains upon which snow lies nearly all the year, and is the sink of two rivers, and from the experience of the explorers quoted, it is fair to assume, that the valley is underlaid by a substratum in which there is plenty of water. By a system of shallow artesian wells, an ample supply could without doubt be obtained, which could be pumped by windmills or would rise in the pipes to an altitude sufficient to cause the water to flow through hose for irrigation. The excessive heat could be modified by putting cloths over the open windows of the houses and keeping them wet with water—a plan adopted in India, where the heat is also very great. Such a plan, with plenty of water, would render life endurable. But Death Valley will scarcely be selected as a desirable place of residence.

It has been shown that water can be found in abundance by sinking wells in almost any part of the valley. Good water was obtained at Greenland at a depth of eighteen feet, and Mr. McCormack found it at McCormack's Wells four feet below the surface.

Dr. George discovered an unmistakable Indian sign. At the mouth of each cañon leading from the valley, in which there is water, he observed a white stone lying on some conspicuous rock, and on looking up the cañon other stones were seen similarly placed, which lead to water if followed. It is useless to look for natural springs elsewhere. Travelers in the desert will do well to look for this sign.

HISTORY.

The emigrant party has been mentioned before, and the reputed discovery of rich mines of gold and silver by them.

After the discovery of the Comstock silver mine in 1858, these old forgotten stories were revived, and in the hope of finding valuable mines, exploring parties were organized to thoroughly prospect the country.

In May, 1860, a party of fifteen men, headed by Dr. Darwin French, left Butte County in search for the Gunsight lead, said to have been found by the emigrants.

They journeyed via Visalia, South Fork of Kern River, Walker's Pass, Indian Wells, and Little Owens Lake; thence, eastwardly, to Hot Mud Springs (which will be described hereafter), to Crystal Springs, Granite Springs, Darwin Cañon, and across the head of Panamint

Valley, thence by a rocky pass to a camp in Death Valley, where the emigrants left their wagons, twenty-five miles a little west of north from Furnace Creek. They discovered and named Furnace Creek, as before stated. The party returned by the way they came, without success as to the discovery they hoped to make. They became satisfied that a pass they came through was the same by which Towne and the saved of the emigrant party made their escape, which led them to name it "Towne's Pass." Among the party were Dr. Darwin French, James Hitchens, N. H. Farley, Dr. W. B. Lilley, Captain Robert Bailey, and J. Lilliard. Darwin, and Darwin Cañon, were named after Dr. French.

October 1, 1860, Dr. S. G. George, Dr. W. B. Lilley, T. J. Henderson, Stephen Gregg, —— Thayer, and J. R. Bill, organized to search for the Gunsight lead. They followed the same general route of the French party, remained at the Emigrant Camp for some time, prospecting the hills in every direction. At a locality two miles distant from the camp, named "Hunter's Point," they found water by digging a few feet, and twelve miles distant a fine spring of good water. Although ten years had passed, the tracks of men, women, and children were distinctly seen, as fresh as if newly made; the irons of the wagons were where they had been left. The remains of ox-yokes were seen, which had been laid out for use on the following day, with the chains extended on the ground in front of each wagon, showing the number of oxen to each, and traces of the old camp fires were plainly seen. Plenty of ducks, small birds, and jack-rabbits were observed. While prospecting the hills, Dr. George and Mr. Thayer found the bones of white men within 300 yards of a spring of good water, believed to be of the emigrant party. The returning party followed an Indian trail to Hunter's Point, and through a mountain pass to Wild Rose Spring, which they named, and at which they camped for two weeks, while prospecting in Panamint Valley. On Christmas day they discovered a mine of antimony, three miles from Wild Rose, which they named the "Christmas Gift." Near this mine they noticed hieroglyphics on the rocks, of a very interesting character.

In March, 1861, eight or ten Mexican miners arrived at the Amargosa mines and commenced active operations. Soon after the Indians made a raid upon them, taking nearly all their provisions. This had occurred several times in the history of the mines. A mill was afterwards built, but was left in charge of two men after an unsuccessful trial of the ores. The Indians killed the men and burned the mill. These mines lie southeasterly from Death Valley, in township 19 north, range 5 east, San Bernardino meridian. They were discovered in 1856, and relocated in 1863. The veins are narrow, but rich in gold. The lowest estimate by C. A. Luckhardt is from eighteen to twenty dollars per ton, with much ore in sight. The gold is found in pockets, from one of which $11,000 was taken.

Mr. McCormack describes them as lying in a belt of diorite, twenty to thirty feet thick, within a country rock of micaceous granite. The quartz is chalcedonic and thin. The whole country is covered with an incrustation of salt. There are springs near by, the water of which is as salt as the ocean.

Nine miles from the mines are the Warm Springs or Saratoga Springs. The water is not only warm, but brackish, and forms a small lake of about an acre in area.

In March, 1861, Mr. Hugh McCormack visited Death Valley. He discovered and named McCormack's Wells, which may be found on some of the old maps. Six miles south of these wells he met with a spring which emitted sulphuretted hydrogen gas. Here the old wagons of the emigrants were found. At Mesquit Springs he saw the shallow grave of a person supposed to be one of the emigrants, probably a woman, as a portion of a calico dress was found with the bones, left exposed by the drifting of the desert sands. Some of the relics from the emigrants' camp have been gathered and placed in the State Museum, where they may be seen by those interested. Efforts will be made to obtain others. Bennett, mentioned before, wandered off in search of water. "Bennett's Wells" were named after him. He walked a day and a half, and found water, and he said, plenty of gold. At one time since, while piloting a prospecting party, he brought a blacksmith's outfit. Anvil Cañon, on the west side of the valley, is supposed to have obtained its name from this, or a similar circumstance. Mr. Hawkins went into the valley by the northern route, which he describes as follows:

Taking the overland train from San Francisco in the afternoon, Reno, Nevada, is reached the following morning, where the Virginia road is taken to the Mound House, and we change cars to the Carson and Colorado Narrow Gauge. After a long day's ride through a comparatively uninteresting country, we reach Candelaria, Esmeralda County, at eight in the evening. From thence the stage can be taken to Columbus, thence via Silver Peak to Gold Mountain, which is our last stopping place before cutting loose from civilization. In the present case the writer found it more convenient to take a team from Columbus, and, after laying in a complete camp outfit, two twenty-gallon kegs for water and provisions sufficient for two men for a week, started. From Columbus our route lay due south to Fish Lake Valley, a charmingly well watered section in comparison to the hot arid desert we were soon to encounter. Through this valley we proceeded to "Piper's," and from there easterly over two mountain ranges, on an excellent toll road, to Gold Mountain, arriving there on the night of our fourth day from San Francisco.

Gold Mountain is the "jumping off place," so to speak, before we enter upon what was but a few years since a *terra incognita*, and here we made our final preparations, and filled our kegs with water.

Our first day's trip was laborious in the extreme. We had an exceedingly steep mountain to cross, and owing to our "buckboard" being heavily laden, were obliged to walk to the summit. The course was southeast from Gold Mountain, and our objective point was some springs called "Coyote Holes," about twenty-five miles distant, which we reached late in the afternoon, and there camped. Early next morning we started, and for twelve miles followed a great salt marsh running east and west. Its crust (being the dry season) was hard and smooth, and glistened in the sun like alabaster. A subsequent examination of this marsh revealed the presence of soda and lime; also, of borax, but not in paying quantities.

At the eastern extremity is another spring called "Poison Springs," the water of which we used for cooking breakfast, but could with difficulty prevail upon our animals to partake of, owing to its brackish taste. From Poison Springs we traveled south through heavy sand until we reached Eutes' ranch, at a place called "Oasis Springs." Here we camped over night and filled our kegs with excellent water.

We were now abreast of the Amargosa, or Grapevine Range, one of the eastern barriers to Death Valley, and I examined these mountains with considerable interest. Owing to their inaccessibility, lack of water, and distance from supplies, these mountains have been but little prospected, although I was shown fine specimens of argentiferous galena and copper, and blende ores from them. Along the crest of the range is a heavy cap of compact lava, extending westward some ten miles, terminating in a bold steep overlooking the wide, rocky desert that surrounds Oasis Springs. From here, eastward, to the "Belted Mountains,'" some thirty miles, this lava extends westward twenty-five miles to the edge of Death Valley; and northward to the distance of about twenty miles the entire country is covered by lava. The principal centers of eruption are indicated by broad, low-angled cones. The Amargosa, or Grapevine Range, shows altered sedimentary rocks, limestone, schists, and quartzite. The strata are greatly disturbed and dislocated, and, so far as the writer examined, only imperfect fossils were found. The Panamint range on the west side of Death Valley appears to be similarly constituted. These ranges are essentially mountains of upheaval, but wherever examined the lavas were present as subsidiary features.

The Oasis Springs are the head of the Amargosa "River," which here is a creek about two feet wide, and which runs down to the desert, a distance of twelve miles, and is then lost in the sand. We journeyed south, following the dry "wash" of the Amargosa, and made a dry camp in the center of the desert. The next day we reached Ash Meadows, where we camped, and on the following morning proceeded southwest, taking a blind trail for some eighteen miles, when we turned abruptly a point of the Amargosa range, and struck northeast over the pass into Death Valley proper, between the junction of the Funeral and Amargosa ranges. That night we made a dry camp on the west side of the summit, and the next day arrived early at Furnace Creek, the principal place in Death Valley, and one of the very few where running water can be found. The trip was wearisome in the extreme, owing to the heavy sand, large rocks, and the daily blowing of violent sand storms.

It might seem strange that any one endowed with ordinary intelligence should wish to make a home in this barren, desolate region; yet such is the case. The *auri sacra fames* has induced prospectors to enter this death dealing valley and explore it, they being amply rewarded, some three years since, by the discovery of a large and valuable tract of borax near Furnace Creek. This passed, by purchase, into the hands of Wm. T. Coleman and Frank M. Smith, of San Francisco.

Telescope Mountain and district were discovered and named by W. T. Henderson, in April, 1861, from the view he obtained from the summit. The country seemed to be spread out like a map—the Mohave Desert to the south, Death Valley to the east, Panamint to the west, and a vast area of distant mountain tops in every direction. The hot mud springs near Coso District, mentioned in connection with the expedition of Dr. George's party, called also "*Hell's Half-Acre*," are thus described by that gentleman :

There are hundreds of these springs; some in constant motion, boiling and bubbling mud. There is one oblong basin, one hundred and fifty feet long by seventy-five feet wide, filled with clear alum water, which ebbs and flows every few minutes. It gradually rises from four to five feet, and as slowly sinks again. A white rock thrown into the spring can be seen to sink for a minute or more. The ground around about is hot. Half a mile west lie extensive banks of sulphur. From crevices steam issues, and on the rocks sulphur in beautiful crystals sublimes. The general character of the surroundings is similar to the mud volcanoes in the Colorado Desert, San Diego County. Four miles distant are low hills of obsidian, several extinct volcanic craters, and walls of lava and pumice stone, all showing that volcanic agencies were once very active at this locality.

Southeast from Furnace Creek, in Death Valley, a tract of singularly pure borax has been discovered, situated high up on the hills; also, in the southern portion of the valley, borax has been found. One of the greatest difficulties experienced in winning borax in Death Valley is the trouble of bringing in supplies. To each supply wagon an equally large one must follow filled with barrels of water for the animals, and it takes some twenty days to make the trip from San Bernardino. This difficulty will be greatly lessened when the railroad is completed.

Borate of lime in apparently large quantities has lately been found, which adds greatly to the importance of the locality; for when the available borax is exhausted, the borate of lime will be utilized.

The Greenland Salt and Borax Mining Company have located their grounds and settlement at the mouth of Furnace Creek, where that stream leaves the cañon through which it flows. The Eagle Borax Company have located at Bennett's Wells, twenty-two miles south from Furnace Creek, and ninety miles north of Daggett Station.

Borate of lime exists at these localities as ulexite, and also as "*colemanite*" (which is a variety of priceite) in beautiful crystals, and pandermite, which is also an amorphous variety of priceite. These minerals have been fully described elsewhere under the head of the mineralogy of borax.

Messrs. Coleman & Smith have not as yet produced borax in Death Valley, but are engaged in putting up works on a ridge quite elevated, at which point they have sunk artesian wells.

The Eagle Borax Company have 270 acres of borax lands, from which they expect to extract a large quantity of borax. Besides borax there is an abundance of thenardite and salt with some trona—(*sesqui-carbonate of soda*). At the present time J. M. McDonald, M. Harmon, C. C. Blanch, and I. Daunet form the company.

The works consist of an iron pan twenty-two by five feet and three feet deep. The fuel used is mesquet wood, of which there is an abundant supply for the present. Fires are built under the pan in which the solutions are made. There are twelve one thousand-gallon tanks of No. 16 galvanized sheet iron, circular in form, with wider bottoms, into which the solutions are run to crystallize. The crystals, of which the specimen No. 4669 in the State Museum catalogue is a type, are taken out every ten days. The crude material (No. 4668) dissolves in the pan with water without leaving much residue.

The borax is hauled to Calico Station via Panamint Valley, Willow, and Granite Springs, Black's Ranch, and Grapevine. The production to the present time has been about 260,000 pounds. The borax is of good quality, and has been sold at ten cents per pound by the carload, and for fifteen cents in smaller quantities.

The first shipment was of the crude natural material, thirty-seven tons, which realized eight cents per pound. This company has made the experience that it is next to impossible to manufacture borax during the hottest season, as the solutions will not cool down to a temperature at which crystallization takes place. A recent attempt resulted in failure for this reason. It is now believed that the work can only be conducted during the Winter, but this will not be a greater hardship than results from the extreme cold of eastern Winters, which, in some cases, is an effectual check to certain manufactures.

The Amargosa borax fields are near Resting Springs, also in Inyo County. The exact locality is township 21 north, range 8 east, San Bernardino meridian. The capacity of the works is eighty crystallizing tanks of 2,800 gallons each. This company will no doubt soon begin to produce borax. William T. Coleman & Co. are the agents.

Soon after the discovery of borax in Nevada several refineries were established in San Francisco, but the market price of the manufactured article was continually falling off, caused by the producers in their efforts to take advantage of the market, and selling the crude material to realize at once. This course produced the very effect they sought to avoid. In the meantime, many costly experiments were made, and when the supply ceased, the works were useless for any other purpose. The first price for refining in San Francisco was forty dollars per ton.

The same difficulties which annoyed the early refiners of crude natural borax, have been met with in California from the date of the first discovery of borax in Nevada. The crude borax from Borax Lake only needed solution and crystallization to yield a product as pure as that obtained from Italian boracic acid by the English manufacturer. But the Nevada crude borax will not part with its mechanical impurities by any simple or inexpensive operation.

Pure borax should dissolve in water to a perfectly transparent solution. No natural borax does this. The so called concentrated borax of Nevada becomes milky in solution; some transparent crystals form when the solutions cool, but for the most part they are opaque, and on being again dissolved, the milkiness reappears, technically called by the refiners "the enemy." When filtered the crystals are pure, but if the clear mother liquors are concentrated by evaporation, the enemy again makes its appearance. It is too costly and inconvenient to filter large hot solutions, and at the present price of borax cannot be afforded.

The secret of refining, therefore, seems to be to get rid of the enemy in the first operation, and by some inexpensive operation. Attempts to solve this problem have cost much money and caused great disappointment, while the results have been only partially successful. Long boiling of the solutions, and standing twelve hours or more in the boiling tank, while kept hot by means of a dry steam coil, has given the best results ; but this operation is expensive, both in time and fuel.

I am informed that the New York refiners adopt the following plan : The crude borax is dissolved in a tank of boiler iron of a capacity of 3,000 gallons, around the sides of which a dry steam coil is placed. The contents of the boiler are stirred by machinery. The plan is somewhat that of the separator of a silver mill, and is driven in the same manner, by gear. The steam coil being on the sides, the bottom is clear, and there is nothing to interfere with the action of the mechanical stirring apparatus. When the proper charge is in solution, three or four pounds of common glue are dissolved in three buckets of hot water, and gradually stirred in. Steam enough is passed through the coils during the night to keep the solution hot, and the whole suspended matter falls to the bottom, leaving the solution clear, which is drawn off in the morning, still hot, into the crystallizing vats, which are allowed to cool slowly in the usual manner.

I have tried this on a small scale in the laboratory with good results, but cannot vouch for its success in the large way.

I lately made the following experiment on a sample of crude material from Death Valley, Inyo County: Solution was made and the sand filtered off, the clear liquid was slowly evaporated in a porcelain dish, a precipitate soon began to form, which was filtered off when the solution had attained a specific gravity of 1.020. The solution was again evaporated. Evaporation and filtration were repeated until a pellicle formed, when the dish with its contents was set aside to crystallize; the crystals were clear, and the mother liquor also; the precipitate was the "enemy," and no doubt the *buttermilk*, *grease*, etc., of the old refiners. It was analyzed by Mr. Edward Booth, and appears in the second report of the State Mineralogist, folio 12, to which the reader is referred.

Many attempts have been made in California and Nevada to produce borax from borate of lime, but up to the present time with only partial success. As the exhaustion of the deposits of natural borax is only a question of time, and as extensive deposits of the borates of lime have lately been found, this subject is one of great importance to the State.

Ulexite was used at Lake Hachinhama, in Lake County, and with what success may be learned by referring to the paper by Dr. Ayres. Boiling for hours in a solution of carbonate of soda failed to effect a complete decomposition, but the then high prices of borax and other circumstances made the operation, defective as it was, one of profit.

The following experiments were made to test the accuracy of an assertion made by Mr. I. Daunet, to the effect that he had wholly decomposed borate of lime from Death Valley by boiling with natural crude carbonate of soda. The sample was a mixture of *cotton balls*, *sheet cotton*, and sand. The distinction between these varieties is explained elsewhere.

When mixed with much water and thoroughly agitated, the ulexite (*a*) remained for some time suspended, and was readily drawn off with the water, leaving the sand (*b*) in the vessel. On standing for some time undisturbed, it wholly settled, leaving above it a light amber colored liquid (*c*). The purified ulexite was very retentive of water. When dried over a water bath it was white and silky, but the long fibers were broken; yet under the microscope it was seen to be a felted mass, entirely free from mechanical impurities. This result verified my experiments made in 1871, and described under the head of ulexite. The sand (*b*) was dried and weighed 0.188 per cent. Examined microscopically it was found to be ordinary desert sand. The amber-colored liquid (*c*) was evaporated to dryness, leaving a white residue (*d*) 3 per cent.

During the evaporation a powdery precipitate separated. This was examined microscopically, and found to be in scales like boracic acid. Another portion of the same precipitate was wet with alcohol and inflamed; the flame had a distinct green color, and showed with the spectroscope the characteristic green bands of boracic acid. This reaction was intensified by repeating the experiment with the addition of sulphuric acid. When again treated with water, a portion of the residue (*d*) remained insoluble, but wholly dissolved in nitric acid, without effervescence.

From the liquid (*c*) obtained in larger quantity by a second operation, octahedral and prismatic borax crystallized out. The crystals were perfectly transparent and hard.

A portion of the original substance was treated with alcohol and inflamed. A strong reaction for boracic acid was obtained, both by the eye and by the spectroscope, proving that free boracic acid was present.

The purified ulexite (*a*) was dried on a water bath, and weighed 48.0 per cent. A portion of the original substance was dried on a water bath; the loss was 47.5 per cent (water).

RESULTS.

a—Dry ulexite	48.000
b—Sand	0.188
d—Borax and boracic acid	3.000
Water	47.500
	98.688

One hundred parts of the dry purified ulexite (*a*) was mixed with one hundred parts of Nevada crude carbonate of soda. The mixture was boiled one hour, during which the volume of liquid was maintained by adding water. The insoluble matter became more and more granular and heavy, no longer floating, but settling to the bottom, leaving a clear solution. In pouring this liquid off, the carbonate of lime separated perfectly, which was dried and examined. It weighed 28.00 per cent. Seen under the microscope, it had lost its silky appearance, and had become white and amorphous. It dissolved in dilute hydrochloric acid with violent effervescence, leaving a residue of mud—9.685 per cent. This residue was fine desert sand from the crude soda. The solution was evaporated to crystallization, yielding borax, 31.6 per cent, which is equivalent to 11.56 per cent of boracic acid. By theory the yield of boracic acid should be 49.5 per cent. These results show the loss of boracic acid to be 37.94 per cent in this practical working, which coincides with operations on a large scale, in which loss has always been admitted.

The method of decomposing borate of lime in England, where muriatic acid is a bi-product in the manufacture of soda from common salt, is as follows: The borate of lime is digested with two thirds its weight of common muriatic acid at a boiling heat until it is wholly decomposed; water is then added to restore that lost by evaporation during the operation. The clear solution is decanted from the insoluble part, and allowed to cool; boracic acid crystallizes out, leaving chloride of sodium, chloride of calcium, and the excess of muriatic acid in the mother liquor. The boracic acid is separated and drained, or pressed, to remove excess of water, and dried.

The Elsworth Borax Company of San Francisco treated borate of lime for several months in 1880 and 1881, but as I learn, with only partial success. They worked a ton of ulexite at a charge, which they decomposed by boiling with concentrated solution of Nevada crude carbonate of soda.

Many tons of ulexite were shipped to Liverpool. From 1873 to 1875, two hundred and thirty-seven tons were taken from Rhodes' marsh in Nevada, and the balance from the Mohave deposit at Desert Springs, in Kern County, California. Works were put up at Columbus, where considerable quantities were treated by the Formhals process. The Mohave deposit was afterwards sold for $5,000.

The following description of the Formhals process is furnished by Mr. H. S. Durden, who has had much practical experience, both in Nevada and California:

MANUFACTURE OF BORACIC ACID FROM BORATE OF LIME.

Several attempts have been made, from time to time, to utilize the borate of lime found in several localities in Nevada and Southern California, for the production of boracic acid. None, however, proved successful, until the invention of Mr. Formhals, of San Francisco, to whom occurred the happy idea of using sulphurous acid; rendering the process simple, cheap, and easily applicable in any locality. This process has been successfully applied, on a practical scale, at two establishments in San Francisco. First, in the works of the American Boracic Acid Company, on Main Street, where between four and five tons were produced from borate brought from Kern County; and subsequently at the Borax Refinery at North Beach, from borate of very low grade from the same locality, and some of superior quality from the Columbus District, Nevada; about the same amount being manufactured as in the former instance. From a chemical point of view, this process is a very elegant one.

A quantity of the crude borate is placed in a wooden tank, and mixed with about three times its weight of water. The mass is then heated by the injection of steam to a temperature of 180° to 200° Fahrenheit. Sulphurous acid gas is then forced in, either by an air pump, or a contrivance known as the Archimedean screw, until the decomposition is complete, which is ascertained in the usual way by means of litmus paper. The whole charge is then run off into a settling tank, where the sulphite of lime subsides to the bottom, leaving the boracic acid in solution in the supernatant clear liquid. This, while still hot, is run off into shallow lead-lined crystallizers, and on cooling affords an abundant crop of very pure boracic acid, seldom containing over four per cent of impurities, consisting chiefly of chloride and sulphate of soda. The apparatus is shown in figure 8: (*A*) Sulphur oven, (*B*) air pump, (*C*) decomposing tank, (*D*) settling tank, (*E*) crystallizer.

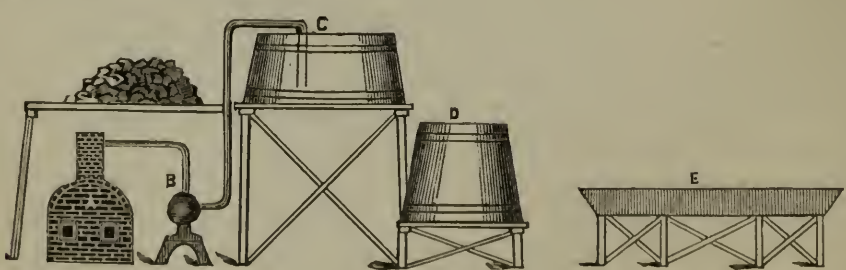

Fig. 8.

Theoretical reactions in Formhals' process: $(2 CaO, NaO, 5 BO_3, 10 HO) + (4 SO_2) = 2 (CaO SO_3) + (NaO SO_3) + (HS) + (9. HO) + 5 BO_3$.

The following is an extract from the San Francisco Mining and Scientific Press of April 7, 1883, relating to a new process for the extraction of boracic acid from ulexite. This process has not as yet been tried on a large scale, to test its practical value:

Wm. B. Robertson, Jr., of this city, has just patented, through the Mining and Scientific Press Patent Agency, a simple and inexpensive means of forming nascent gases directly and upon the spot; and, also, a process for treating the borates with them. The process is such as to avoid expense; and one advantage is that the waste is avoided attending the employment of the sulphuric acid of commerce when poured directly into the borate solution.

The object of the process is twofold, namely: to set free the boracic acid more rapidly and effectively, by the employment of a strong reagent, and to cheapen the cost of operation by providing a means for making this reagent directly and in close connection with the substance to be acted upon, whereby the necessity of two operations, to wit: the separate and expensive manufacture of the sulphuric acid, and its transportation as such to the field of operation, is avoided. The process consists in a means of forming nitrous and sulphurous vapors, and admitting air thereto, and in a means for forcing said vapors into a tank containing a suspension or solution of the borate.

A tank is provided for the solution, and an ordinary furnace is used for containing sulphur to undergo combustion. In this furnace is a pot containing any suitable nitrate. The furnace has a front aperture with a sliding door, so as to admit more or less air. A pipe connects the furnace with the tank, said pipe extending down in the tank nearly to its bottom. A steam boiler is provided, from which is a pipe extending into the other pipe, which connects the furnace and tank so that pressure of steam will act as an injector, and carry the furnace vapors into the borate solution in the tank.

The process is as follows: In the tank is placed water, and the borate introduced. If borate of soda, a solution is formed; if borate of lime, or magnesia, they are held in suspension. In the furnace is placed sulphur, and it is ignited. The pot rests over the sulphur and contains any suitable nitrate—such as nitrate of soda—which is commonly used in the manufacture of sulphuric acid. In order to start and assist the operation, Mr. Robertson places in the pot with the nitrate a small quantity of hydrated sulphuric acid. In this furnace are formed, as is well known, the nascent gases of sulphuric acid, namely, the nitrous and sulphuric vapors, which, together with the air drawn in through the front of the aperture, contrive to produce the result. The steam from the boiler passing through the pipe acts as an injector, and forces or carries with it these vapors through the furnace pipe into the borate solution or suspension in the tank.

The effect of this is that sulphuric acid is formed and introduced directly to the solution. It takes up the soda, lime, magnesia, or whatever may be the base of the borate, and precipitates it as a sulphate. The boracic acid is set free, and the solution may be drawn off, where it crystallizes in a free state in the proper crystallizing pans. The effect of the acid in the borate solution is the same, whether this latter be cold or hot; that is, the reaction takes place, and the boracic acid is liberated, so that at the beginning of the operation, when the solution is cold, the operation is taking place; but before the process is complete the solution warms up under the steam, so that when ready to be drawn off it is hot enough to provide for the proper crystallization of the boracic acid. Thus no time is lost, and the means will conduce to the end. This treatment with sulphuric acid formed directly and in connection with the borate solution, the inventor deems preferable to the treatment with sulphurous acid gas, because he attains a stronger and more effective reagent with a little trouble. The great advantage possessed by the process over that in which the hydrated sulphuric acid of commerce is used is that it is more economical, both in trouble and expense. Of course Mr. Robertson is aware that heretofore borates in solution have been treated with sulphurous acid, and does not broadly claim this, but confines himself to the details described.

The Gutzkow patent process has not, as I believe, had sufficient practical test to prove its value, or otherwise. The following detailed description is quoted entire from the Proceedings of the California Academy of Sciences, April 7, 1873:

A NEW PROCESS FOR THE EXTRACTION OF BORACIC ACID.

[By F. Gutzkow.]

I beg to bring to the notice of the Academy a process for the working of borate of lime, which, besides that I consider it to have some claims as to practicability, presents, also, some scientific points which may be sufficiently interesting to some of the members as to warrant me in drawing their attention thereto.

The Academy has already been made aware of the fact, that in the State of Nevada lately, large masses of borate of lime have been discovered in different places in Churchill, Esmeralda, and other counties. It is interesting, because boracic acid is by no means very profusely distributed on the earth's surface, and borate of lime in particular, has, until now, only been found near the celebrated nitrate of soda deposits of Iquique, in South America. The mineral found in Nevada is the same as the South American. It is not the true borate of lime, but the boronatrocalcite, a combination of the borate of soda with the borate of lime. An analysis made by myself, gave, in round numbers—

Boracic acid	42
Lime	13
Soda	8
Water	37
	100

There appears to be some difference in the impurities found with it. In Nevada they appear to be principally clay, while in South America, gypsum is always, more or less, found intermixed.

Owing to these impurities, there have been experienced some difficulties in working the mineral in England and France; but still more has the expectation that the South American borate of lime would give a prolific source of borax been reduced by the circumstance, that the shipments from Iquique turned out to be of very unequal nature as to quality, which, with the difficulty of ascertaining the true proportion of boracic acid by an easy assay, rather demoralized the market for the substance in question.

In this country, the process used for working it consists in a kind of concentrating operation, by which, with an enormous loss in substance, the borate of lime is freed from impurities. Then it is boiled with a solution of carbonate of soda, and the solutions obtained worked for a crude borax, to be refined afterwards by recrystallization. This process has several important drawbacks. In the first place, the high price of soda on this coast interferes seriously. Although the State of Nevada possesses large deposits of crude soda, it becomes so dear by the high cost of transportation, that in this city it is about as advantageous to employ the English sal-soda, which is, besides, a much purer article. Furthermore, the decomposition of the borate of lime is not complete by soda, and the residue will always contain some undecomposed mineral, unless a very large quantity of water is used. As the borate of lime is not insoluble in water, it is possible to extract by water alone, all traces of the mineral; but on the large scale, this is, of course, not feasible. In the third place, the clay mixed with the mineral, and the carbonate of lime formed by the soda, make the residue extremely bulky. It takes a long time to make it settle into a pulp of some reasonable thickness; therefore several washings are required to wash the absorbed borax solution out, thus yielding weak solutions, which have to be worked up and concentrated.

In view of these facts, I thought it advisable to devise a better process than the one described. My process is based upon the volatilization of boracic acid by water vapors; a fact which nature itself proves, by furnishing in that way all the boracic acid manufactured in Tuscany. But by my own experiments I discovered that volatilization can be made complete; that is, that a given quantity of boracic acid can be completely volatilized by steam alone.

The plainest experiment which laid the foundation to my process is this: To melt in a platinum crucible some boracic acid into a glass, weigh the crucible with contents, and conduct steam by a brass tube into the crucible while the latter is heated to redness. By weighing from time to time the process of volatilization may be observed. After two hours continuing the experiment, more or less, the crucible will be found entirely empty. Other experiments by which I suspended a weighed platinum wire, on to which a pearl of boracic acid was molten, in an iron gas pipe, and conducted steam of different temperature through that apparatus, showed that the speed of the volatilization is entirely depending upon the temperature of the steam. Steam of 212° Fahrenheit is not capable of removing more than traces unless the reaction is allowed to continue for a very long time. If the gas pipe surrounding the boracic acid pearl is, however, heated to redness, the volatilization is most rapid.

The rather surprising fact that the steam of 212° Fahrenheit has so little power for the purpose caused me to experiment on some statements made by Henry Rose, the celebrated chemist to whom we are mostly indebted for our knowledge of the element *Boron* and its combinations. Rose states that it is not possible to concentrate a solution containing free boracic acid without loss of substance. I found this correct when the solution is evaporated in an open dish, but not so when the concentration takes place in a glass flask. On concentrating a quite concentrated solution of boracic acid in a glass flask, over a moderate fire, I never could condense more boracic acid than the mechanical carrying off by the vapors would account for—that is, a trace. In an open dish, however, in the progress of concentration, a ring of boracic acid separated on the dish, which boracic acid is heated much more than the solution, and is exposed to the action of the steam rising from the liquid. In that case a volatilization takes place.

Having found out that superheated steam is much more powerful in carrying off boracic acid than steam of 212° Fah., it was easy to conclude that the condensation of the volatilized boracic acid could not present great difficulties. The boracic acid volatilized in the apparatus described before, that is, in a heated iron pipe. By regulating the length and temperature of the pipe the fact resulted that the steam could be deprived nearly entirely of its percentage in boracic acid.

From these facts the following process of working borate of lime suggested itself:

The borate of lime can be used as found on the borax marshes, or more or less purified if it has to be transported some distance. It is placed in a lead-lined shallow pan, covered with half the weight of water, and allowed to stand for a day, or longer, in order to allow the lumps to dissolve. Then from one quarter to one half the weight of sulphuric acid is added, and the whole well stirred into a stiff pulp, which is taken out and thrown in a heap. After some days the mass has become hard, as the gypsum commences to set. With this first operation the mass is ready for the second operation—the distilling with steam. It is done in an iron retort with an arrangement for heating it. An ordinary gas pipe, twelve feet by one and a half feet, would answer very well. It ought to stand in an upright position, in order to facilitate the charging and discharging, as also to cause an equal action of the steam. When the pipe is sufficiently heated that no condensation of steam can take place, steam is admitted. It becomes superheated within the retort, and carries along the boracic acid, leaving a porous mass of gypsum, etc., which, when the operation is continued sufficiently long, will be found entirely free from boracic acid. It has been mentioned before that the rapidity of the action depends only on the heat employed. If the temperature of the retort is near the red heat, from one to two hours will suffice to finish the operation in the lower part of the retort. At a temperature only, say 400° Fah., which is very easily reached within the retort, about four hours will be required.

The details of the apparatus which allows a continuous working, and by withdrawing only half the contents every few hours, allows the mass to be exposed twice as long, that is eight hours, to the action of the steam, I will omit here.

The steam which leaves the retort is highly charged with boracic acid. It can be made to absorb not less than the fourth part of its weight of the hydrated boracic acid. From the retort it passes into a brick or lead-lined wooden chamber, where most of the hydrate of boracic acid will deposit. Thence it passes into another chamber, or better, a long flue provided with some metal grating, before it escapes into the atmosphere. Also, a worm condenser can be used, and with it a strong solution of boracic acid will result. It may also pass through a coil of lead or other metal, which utilizes the waste heat. There are numerous devices to remove, by partial condensing, the last traces of boracic acid, if desired.

Most of the boracic acid is, however, found in the first chamber as hydrate, BO_3+3HO, and can be from time to time removed. It can be easily melted into a glass, taking care to condense the fumes during melting, and is then absolutely pure. In the state as found in the chamber it may contain a little sulphuric acid, but by admixture of some coke and charcoal with the top layer in the retort, the sulphuric acid can be entirely converted into sulphurous gas, which escapes, uncondensed, from the chambers. There is no other substance present to interfere with the purity of the product obtained. In a mechanical way nothing can go over, as the mass within the retort gets all glazed over by boracic acid.

The advantages of the process are, that with very little labor in one single and short operation, the mineral can be exhausted. There are no rich residues left to be worked over, nor liquor to be concentrated, which makes the lixiviation process so complicated. Besides, the boracic acid, and particularly the boracic acid glass, can bear the high cost of transportation from the borax marshes much better than the borax or the borate of lime. To bring one pound of borax from the marshes to the market, that is New York or European ports, costs now from six to seven cents. To transport the molten boracic acid which gives three pounds of borax nearly, would reduce the cost for one pound of borax by two thirds.

BORAX IN NEVADA.

What is known as the great basin is a peculiar geographical feature of the Pacific Coast States. It is a depression between ranges of mountains, from which there is no outlet to the watershed. Streams, generally small, which head in the snowy mountains, if they do not sink in the sandy desert soil, or wholly evaporate, give birth to alkaline lakes, of which Mono, Owens, Walker, Carson, and Humboldt are the most important. There are a multitude of lesser "*sinks*," as they are called, which are subject to great vicissitudes. During a season of unusual rainfall, or a phenomenal winter accumulation of snow on the mountains, great sheets of water are formed in natural depressions on the alkaline plains, which, when the conditions vary, appear as extensive fields of dry, white, efflorescent salts, consisting wholly of soluble matters gathered by the water in its passage from the melting snows, which it left in a state of almost absolute purity. The soil is generally sterile, except in certain valleys, and is largely composed of the debris of volcanic rocks and lavas, rich in soda feldspar, which readily parts with its alkali. Immense flows of a peculiar yellowish semi-crystalline lava have covered the country for many square miles. They seem to have had their origin at or near the circular basin in which Mono Lake lies, and they extend quite to the base of the great White Mountain range which forms the northern part of the Inyo Mountains.

Owens River cuts through this formation in its passage to the valley, having excavated a cañon hundreds of feet in depth. The same formation crops out at Adobe Meadows, at Benton, Whisky Flat, and elsewhere.

The waters of Mono and Owens Lakes are of the same general character, although more than one hundred miles apart, and they both contain boracic acid in solution. They have other features and peculiarities in common. Both cover nearly the same area. Both are subject to rise and fall, according to season. Both deposit the rock or mineral called "*thinolite*," which forms when the waters become supersaturated. The waters are very heavy. When shaken in a glass bottle they appear like thin oil. When thrown on a flat surface a voluminous white incrustation is left as the water evaporates. At the margin of the lakes a peculiar disagreeable smell is observed like that of an adjacent soap factory. The waters possess great detersive properties. When mixed with oil and shaken in a bottle, an emulsion is formed, which is an imperfect soap, and the oil cannot be made to separate even by long standing. If boiled, the saponification becomes perfect. The specific gravity of a sample of the waters of Mono Lake in the State Museum is 1.038. It acts immediately on animal matter. If placed on the skin, that smoothness caused by caustic potash, well known to chemists, is soon observed.

If to the water hydrochloric acid is added, a brisk effervescence is the result. Boiled in a silver dish to one half, only a small precipitate falls, but the dish becomes blackened from hydrosulphuric acid present. A litre of the water contains 41.8 grains of solid salts, consisting largely of chloride of sodium, sulphate of soda and carbonate of soda, with borax or boracic acid, as before mentioned, in very much smaller proportion, and probably other valuable substances. No complete analysis has yet been made, but samples have been obtained from the most important lakes of the State for that purpose. I have before predicted, and now repeat the opinion, that these lakes will eventually be utilized, and the salts they contain extracted with profit to those who may engage in the business, and to the general advantage of the State.

It is not easy to account for the boracic acid in these waters; the theorist is at a loss to decide from his limited knowledge whether borax, ulexite, priceite, pandermite, etc., are derived from the decomposition of other borax minerals, such as tourmaline, datolite, danburite, and axinite, which may exist in the crystalline rocks in greater quantities than is generally supposed, from volcanic or solfataric agency, like the Italian deposits, boracic acid being given off in steam jets, and combining with the soda of the carbonate known to exist in the waters of these or similar lakes of a former period to form borax, and with soluble lime salts, to produce ulexite, or, if the rivers have brought down soluble borates gathered from the soil which may have derived its boracic acid from the volcanic rocks before mentioned. Whatever theory or theories may be advanced, the fact remains, that fields of borates in very large quantities at some localities, and in spots and patches at others, are known to extend from Oregon to Arizona, and over a vast scope of country.

The history of the discovery of borax and borates in Nevada, which followed that of Borax Lake in California, already mentioned, may be summed up as follows:

The first borax mineral found was ulexite, in the form of cotton balls, as they are called, thus named from the silky felted or interlaced crystals which the globular masses show when broken. They were from the size of peas up to twelve inches in diameter.

In 1860 Dr. Veatch met Mr. William Troop in Virginia City, and told him that he had tested water from Mono Lake, and had seen indications of borax in it, and also in some minerals from the same locality, and thought borax would eventually be found in Nevada.

In 1864 Columbus Marsh was located by Smith & Eaton as a salt bed. Some borate of lime was then found, but no notice was taken of it until a specimen came into the hands of Dr. Partz, then engaged in metallurgical operations at Blind Springs, Mono County, California. He recognized the mineral, but did not attach any special importance to the discovery. Specimens were sent to the Eastern States, which were noticed in Dana's Mineralogy, and found a place in the cabinets of mineralogists.

In the latter part of 1869, a teamster, as he drove along the road to Wadsworth, walking beside his slowly moving wagon, picked up a cotton ball, which he broke open, and noticing and admiring the silky crystals, brought it with him as a curiosity. It found its way eventually to San Francisco, where it came to the notice of certain well known capitalists, who sent out a prospecting party to search for the locality. After a fruitless hunt the party was about to return to San Francisco disappointed, when Mr. W. H. Burgess, an old resident of Nevada, and keeper of the well known Burgess Station, directed them to Virginia Marsh. While they were gone, he discovered the place where the teamster found the cotton ball specimen. On the discovery becoming known, a systematic search for borax commenced, which has continued with intermittent activity to the present day. In 1871, Mr. Troop discovered borax (cotton balls) three miles from Columbus, Esmeralda County. About the same time he found a deposit forty-five miles southeast of Ragtown, near Salt Wells, at which spot he located the property afterwards owned by the American Borax Company. He brought a sample to Ragtown, obtained a wash boiler from Mrs. Kenyon, and carbonate of soda from Ragtown Lake, which he boiled with the cotton balls and water, obtaining the first borax ever made in Nevada. Flushed with the success of the first operation, he brought 1,700 pounds of ulexite from near Columbus, which was made into borax in San Francisco by Mosheimer & Stevenot, at North Beach. The first yield was sold to Isaac S. Van Winkle, iron merchant, of San Francisco.

In April, 1872, Dr. Degroot wrote to the San Francisco Evening Bulletin as follows:

> At Sand Springs, fifty miles east of Wadsworth, there is a large area covered with borate of lime, and there are works capable of manufacturing a ton of borax per day running with profit and success. On an alkali flat, twenty miles southwest of Wadsworth, borax salts are found; also, at Hot Springs, nineteen miles northeast of Wadsworth.
>
> A few hundred yards northeast of Ragtown Lake there is a small lake about one and a half miles in circuit, the waters of which are supersaturated with salts, including borax. The lake has no outlet. A few years ago a San Francisco company attempted to work it for borax, by pumping the water and conveying it to an alkaline flat, where it was supposed to evaporate by the sun's heat. The operation was not a success, and was abandoned.

TEEL MARSH BORAX FIELDS.

Teel Marsh, or Teel's Marsh, Esmeralda County, Nevada, lies about sixteen miles northwest from Columbus, and about the same distance west of Virginia Marsh. As far as I can learn, it takes its name from quantities of ducks which were found there when first discovered. This is, and has been, the most productive borax field yet found on the Pacific Coast. The following account of its discovery is from the Scientific American of October, 1877, and approved by the gentleman named as being substantially correct:

This remarkable discovery was made in Esmeralda County, Nevada, October 12, 1873, by a young man who was prospecting for mines of gold and silver. While thus engaged, wandering over mountains, cañons, and valleys, he discovered in a valley known as Teel's Marsh which appeared (in the distance) to be a vast bed of white sand, resembling dry sea foam. Upon arriving at the place, he found it to be the bed of a dry lagoon, with the appearance of having been dry for centuries. He found the surface to be soft and clayey, often sinking ankle-deep. After an examination of the curious deposit, he put several handfuls into his pockets and returned across the mountains to Columbus, a distance of twenty miles. There an assayer pronounced it the richest sample of crude borax he had ever seen. It soon proved to be an enormous deposit of crude borax, two and one half miles wide and five or six in length. It was more than one man could manage, so a brother was sent for, and the two (now widely known as the Smith Brothers of Nevada) worked with a will, sparing neither time nor money until the whole deposit was their property. They at once obtained boilers, tanks, crystallizers, etc., from Chicago, and began operations. The result is, that in the course of three or four years the brothers have perfected an immense establishment, and are producing an enormous quantity of a chemically pure article of borax, which stands first, and is in demand in every household, to whom it is supplied by grocers and druggists throughout the country.

It will be seen, by referring to the statistics relating to the production of borax on the Pacific Coast, that a large quantity has been obtained at this locality, and there is reason to believe that much more will be extracted.

The method employed by Smith Brothers for the production of borax from the crude material is by solution, separation of mechanical impurities by settling, and crystallization. The result is *concentrated borax.* When this is recrystallized, it is known as *refined borax.* The deposit is known as *crude borax,* specimens of which may be seen in the State Museum, numbered 3380 and 3381. It occurs as a superficial stratum, varying from half an inch to eighteen inches in thickness. This is raked into windrows, shoveled into wagons, and hauled to the borax works, situated on a small hill near by. The heat required for solution is obtained from two twenty-four-inch steam boilers, which are supplied with water by a Cameron & Douglas steam pump. There are nine boiling tanks, of boiler iron, eight feet in diameter and seven feet deep. From the boilers the steam is conducted to the boiling tanks through two-inch iron pipes to a wet coil of a peculiar form—shown in figure 9—a vertical pipe, carrying the steam to the center of the coil (if this is a proper term), which is pierced full of small holes, through which the steam escapes into the solution.

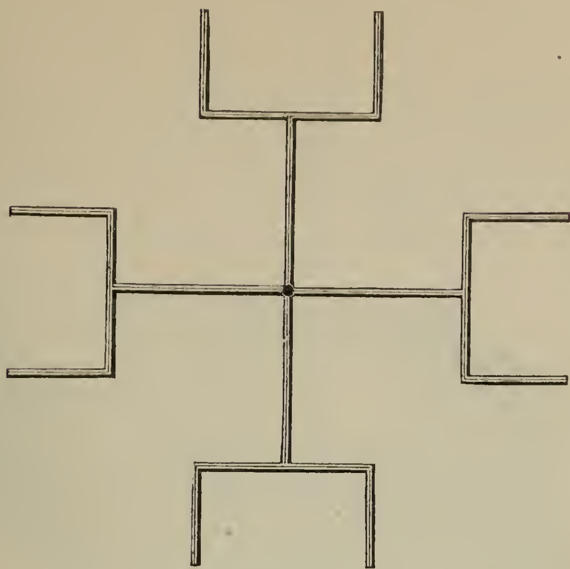

Fig. 9.

The operation is commenced by filling the boiling tanks one third to one half full of water, according to the quality of the crude material, as learned by experience. When the water is boiling hot, the crude borax is shoveled in until the solution has a density equal to 20° to 30° Beaumé's hydrometer. The hot solution is allowed to stand over night, the steam being turned off. In the morning the solution, now free from sand and other mechanical impurity, is run off into crystallizers of No. 14 galvanized sheet iron. These vessels are square, seven feet at the bottom and six feet at the top. They are provided with covers of No. 16 galvanized sheet iron. As the solution cools, crystals of borax form in these crystallizers in crusts varying from half an inch to four inches in thickness. As soon as the boiling tanks are discharged, the mud is sluiced out; they are then pumped partly full of water for the next operation. When crystals cease to form in the crystallizers the mother liquor is drawn off, and the crystals removed from the sides and bottom, and returned to the clean boiling tanks in which they are redissolved and allowed to stand for a time undisturbed, as in the first operation, when the solutions are drawn again into the crystallizers. The result is *concentrated* borax. The mother liquors from both operations are run off into shallow pans of wood, covering half an acre, in which solar evaporation takes place, salts containing some borax crystallize out, after which the very impure mother liquor is allowed to go to waste. The plan of calcining to remove organic matter has never been practiced, although it should be.

The hot liquors are drawn from the surface in the boiling tanks by an ingenious device, which consists of a *goose-neck* of three-inch iron pipe, connected with a common flexible hose of the same diameter. The joints are common elbows and nipples. A three-inch pipe passes up through the bottom of each boiling tank near one side. The boiling tanks are set in a row, fifteen feet above the crystallizers; the pipe rises a few inches above the bottom, to allow for the settling mud. On the end of this pipe a common elbow is loosely screwed; in this is screwed a nipple, another elbow, and a length of pipe nearly as long as the bottom of the tank. This long pipe turns freely, and can be elevated or depressed at pleasure, and extends obliquely to the surface of the fluid. The elbows are all loose, being only screwed hand tight. When it is required to draw off the liquors, the end of the pipe is depressed, until the opening is just below the surface. The solution flows down through the pipe without disturbing the sediment. By means of the hose, the liquors are conveyed to either of the crystallizers at pleasure.

Figure 10 shows the boiling tank and goose-neck in section.

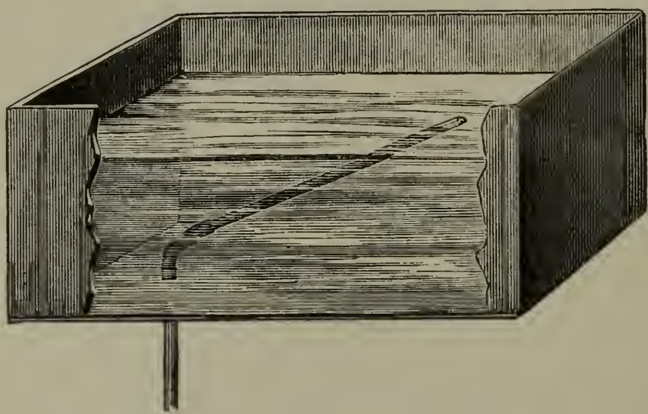

Fig. 10.

RHODES' MARSH.

The following description is condensed from a report by J. R. Scupham, C. E.:

Rhodes' Marsh, Esmeralda County, State of Nevada, occupies the western portion of a valley about twelve miles in diameter, surrounded by ranges of hills and isolated mountains. From a height the so called "marsh" resembles a frozen lake covered with dirty snow. The line of the Carson and Colorado Railroad is seen crossing its western edge, with the depot and borax works upon this portion, and long lines of spur tracks from the railroad radiating out on its surface.

The most concentrated portion of the marsh contains about two thousand three hundred and fifty-seven acres. But borate of lime and other borax compounds are found over a surface of four thousand acres, all of which land is the property of the "Nevada Salt and Borax Company."

Though termed a marsh, there is no water on the surface, except where springs here and there wet a small patch, or send out rills which soon sink beneath the surface.

On close inspection the whole surface of the marsh is found to be incrusted with various salts, while here and there are patches covered with snow-like efflorescence.

A close inspection shows also some difference in the character of portions of the marsh. Beginning at a point near the center of the western margin and following north in a strip varying in width, and also along the whole northern and northeastern portion, is a belt of the marsh, containing, under a brownish, salty crust, disseminated through six or eight feet of clay, masses and beds of snowball-like concretions of borate of lime, called here "cotton balls" or *ulexite*. This portion of the marsh contains about six hundred acres. The cotton balls can be easily gathered from the mud matrix, especially where they lie in thick beds, as they do in patches acres in extent.

These "cotton balls" look like a dirty snowball when first taken from the mud. When broken open they are found of a wavy, fibrous texture, white, with a silky or pearly luster. They vary in size from that of a pea to four inches in diameter.

These balls of borate of lime are also found occasionally through other portions of the marsh, sometimes even in the solid beds of salt.

The lowest portion of the marsh has a slightly undulating surface, and a thick, hard crust, containing, with chloride of sodium, a large amount of biborate of sodium and borate of lime. Under this crust is a solid bed of pure salt (chloride of sodium) eight to twelve feet thick. Long trenches are opened in this salt four to five feet deep, twelve feet in width, and as long as desired. The old salt removed is shoveled on to cars and sold for use in the quartz mills at nine dollars per ton. The bottom of the trench, when the old salt is removed, fills rapidly with a clear, sparkling water, intensely salt. In this water crystals of salt immediately begin to form and fall to the bottom in a snow-white deposit. In ten days six or eight inches in depth will have formed. It is then shoveled on to cars and taken to the works to be ground up for fine table salt. This is purer than the best Liverpool salt, and the production costs, besides the sacking, not more than eighty cents per ton delivered at the railroad. There are about four hundred acres of this salt ground.

South of the salt beds, lying in a zone about one and a half miles long, in the center of the marsh, is a tract of about four hundred and eighty acres, containing tincal (native borax crystals). This is the richest and by far the most interesting portion of the marsh. For three or four feet in depth the material is a stiff gray mud, through which are thickly disseminated the translucent gray crystals of tincal. These crystals are from the size of a grain of wheat to two inches in length by one inch in diameter.

Underneath this tincal mud is a solid surface exactly like ice and called by that name here. It is sulphate of soda with some borax. This solid "ice," so far as I know, has never yet been cut through. At one place I saw it cut into six feet, all the way showing like solid dusky ice.

That portion of the marsh lying west, south, and east of the tincal deposit, containing in all about two thousand acres, is covered with a crust from two to six inches deep, containing biborate of soda in a powdered state, mixed with hard clay.

As it only requires the simplest treatment to produce borax from this for the market, the company is confining its attention entirely to this section at present, and it will be years before any other source need be touched.

The amount of sulphate of soda underlying all these borax beds is well worthy of consideration, as caustic soda and carbonate of soda can be made from it sufficient to supply the American market. And as the uses of these chemicals is greatly on the increase, their production might become a source of great revenue to the company. At present these soda salts are largely manufactured from cryolite, imported from Greenland.

The work of producing borax out of such excellent material is very simple. Indeed, the borax is already there and only requires dissolving from the adulterating mud and recrystallizing.

At the railroad station, on the western portion of the marsh, the company has its works, consisting of a warehouse, an engine and boiler-house, four boiler-tanks (7x8), twenty-four crystallizing tanks, waste tanks, etc.

The company has also a salt mill in the warehouse for grinding table salt.

The attention of the company will be confined, for a decade at least, to the manufacture of borax from the native borate of soda. To do this, the top crust to the depth of six inches is shoveled into cars, taken to the works, and dumped into the boiling tanks, which are partly filled with water from a well strongly impregnated with borax. The tanks are then boiled by steam from the boilers until the borate of soda is all dissolved, when it is allowed to settle. The water containing the solution is then decanted into the crystallizing tanks, which are of galvanized iron, with sheets of the same material suspended in them. Here the borax crystals form on the sides and on the plates to the depth of about two inches. The water is then run off into the waste reservoir and saved, for it still contains some borax. The borax crystals are knocked off and shoveled up. This constitutes the "crude borax" of commerce, really worth more than the "refined," because it contains an excess of boracic acid. This is now redissolved and mixed with carbonate of soda, to reduce it to the standard. At 18° Beaumé it is again decanted into crystallizing tanks, where "refined borax" is finally formed.

The capacity of these is calculated for fifty tons per month and for some time they have been producing at fully that rate.

What has been shipped has proved to be the very best in the market.

With these works running smoothly, borax can be produced at ten dollars per ton.

As I have before stated, the amount of the product is dependent on the will of the company. The raw material in the marsh is practically unlimited and the capacity of the present works can be increased four or five times, simply by adding tanks and boilers.

It costs $12 50 per ton to freight borax from Rhodes' Marsh to San Francisco.

The "Nevada Salt and Borax Company" is incorporated under the laws of California, with 100,000 shares of stock, at a par value of $10 per share. Besides this, bonds were issued for $100,000, and the money used to purchase and equip the property. These bonds run fifteen years, and bear interest at seven per cent. United States patents are issued for all the lands of the company, consisting of 4,160 acres.

The following are the analyses of the samples taken from different locations, which were made by A. A. Hebberling, chemist, United States Mint, Carson City, Nevada, March, 1882:

No. 1, Borax—From the southeast part of the marsh, about a mile and a half from the house of Messrs. Rhodes and Wason—is the crude borate of soda. The material covers the surface to the depth of from one to five inches, and embraces an area of about forty acres.

ANALYSIS.

Borate of sodium	40.06
Borate of calcium	1.16
Sulphate of sodium	16.00
Carbonate of sodium	5.00
Chloride of sodium	8.07
Organic matter, sand and iron	29.71
	100.00

No. 2, Borax—Taken directly north of place mentioned above. It covers about one hundred acres of ground to the depth of from two to eight inches, and will furnish a splendid material for manufacturing borax. Mr. Wason supposed this material to contain free "boracic acid," but it does not, as is shown by the presence of free carbonate of soda.

ANALYSIS.

Borate of sodium	57.20
Borate of calcium	5.80
Sulphate of sodium	10.70
Chloride of sodium	9.00
Organic matter and sand	17.30
	100.00

No. 3, Salt Crust—A small deposit around Rabbit Springs, and hardly worth mentioning.

ANALYSIS.

Carbonate of soda	19.6
Sulphate of soda	8.7
Borate of sodium	10.0
Sand and insoluble matter	61.7
	100.0

No. 4—Siftings from cotton balls. Very rich in borate of lime.

No. 5—Sample from ground running southwest to northeast, around east side of marsh. This is a very important part of the marsh, as it covers a large area of ground, and is capped by a crust of salt, containing a large per cent of borax. The cotton balls are found under ground, from half a foot to six feet deep.

No. 6, Soda—Crust from top overlying borate of lime, about one and a half miles north of house. It covers considerable ground, with a fine deposit of borate of lime underneath.

No. 7, Salt Crust—Thickness from two to six inches, overlying a fine and large deposit of borate of lime. It is two miles from the house, a little west of north.

ANALYSIS.

Carbonate of soda	8.07
Chloride of soda	15.90
Sulphate of soda	20.10
Borate of soda	15.05
Sand	40.88
	100.00

No. 8—Sulphate of soda and lime.

No. 9—Sample from the vicinity of salt beds.

ANALYSIS.

Borate of sodium	14.6
Sulphate of sodium	30.5
Chloride of sodium	26.6
Carbonate of sodium	trace
Sand and clay	38.3
	100.0

Nos. 10, 11, 12—Contain sulphate of sodium, with but trace of borax.

No. 13, Brown Crust—One and a half miles west of house. The center of a very extensive deposit of natural crystals of borax, called "tincal," extending from the surface of the ground to a depth of three or four feet. Even the brown crust overlying the clay containing the crystals is very rich in borax.

ANALYSIS.

Borate of sodium	36.5
Sulphate of sodium	16.5
Carbonate of sodium	6.8
Chloride of sodium	15.0
Earthy particles	25.2
	100.0

The sample of water near "Borax Spring" yields 120 pounds of borax to the ton.

Rhodes Marsh lies in Sections 14, 15, 16, 21, and 22, township 5 north, range 35 east, Mount Diablo base and meridian.

The following letter from Professor Joseph LeConte is given here by his permission:

BERKELEY, CAL., November 1, 1882.

MR. J. R. SCUPHAM:

DEAR SIR: At your request I hereby give you a brief sketch of my observations at Rhodes' Salt Marsh. I wish you, however, to understand that the object of my visit was purely scientific, and therefore I made no attempt to form an accurate estimate, based on personal observation, of the actual quantity of valuable salts in the marsh.

The marsh is nearly circular in form, and, as near as I can judge, about two and one half to three miles in diameter, and contains about five or six square miles. The central part (perhaps one square mile or more) is covered with pure salt—chloride of sodium. Around this, to the margin, the nature of the deposit differs in different parts. In some parts borax in the form of crust; in some, borax in the form of tincal; in some, ulexite (a soda-lime borate); in some, sulphate of soda, and in some, carbonate of soda. Common salt is found nearly everywhere, more or less mingled with the other salts, but in a pure condition only in the central portion of the marsh. I will take up these successively:

1. *Common Salt.* This exists in practically unlimited quantity, and can be gathered in a chemically pure state, with apparently no more trouble or expense than would be necessary to gather so much earth. This is so obvious to every observer that nothing more need be said.

2. *Borax.* Borates exist here in three forms. (*a*) It occurs as a borax crust from one to three inches thick, more or less mingled with earth, the borax being perhaps fifty per cent of the weight. It is easily gathered with a shovel. I do not know the exact area of this crust, but it is evidently very large. I observed, also, places where the crust had been removed a year or two ago, and on which it had been re-formed, although not yet so thickly as before removal. The most extensive crust area is on the southern portion of the marsh, not far from the works. Several springs containing borax in this vicinity suggest the mode in which the crust was formed.

(*b*) Borax occurs also as tincal. In many parts of the marsh, notably on the west, southwest, and southeast of the central *salt area,* if the loose surface earth be removed until stiff, moist, blue clay is reached, and then a spadeful of this blue clay be turned up, it is found to be full of transparent crystals from a half inch to one inch in diameter, looking like fragments of ice. These crystals are pure borate of soda, or borax, in the form called tincal. Some spadesful thus turned up, I think contain fifty per cent of tincal. Of course I only turned up the soil here and there to examine the mode of occurrence. I am sure, however, that this form of borax occurs over a very wide area, but whether universally, or equally distributed, I cannot say. My chief interest was the question of the formation of these crystals. This point is still obscure, but they must have crystallized from a saturated solution, and therefore, in addition to the crystals, a considerable amount of borax crust exists in solution in the water which saturates the clay.

(*c*) Borate occurs also, and probably in very large quantities, as ulexite, or soda-lime-borate, or "cotton balls." These curious balls occur in a semicircular area surrounding the central salt area on the north, northwest, and northeast. They are imbedded in a wet, stiff clay, like the tincal, and are gathered in the same way. When the loose earth is removed to the depth of a foot or so, until the stiff clay is reached, then a spadeful of clay is seen to contain irregular elipsoidal white balls, much the shape and size of potatoes, and may, in fact, be dug like potatoes. On breaking one of these, the beautiful, radiated, silky fibers characteristic of ulexite are seen. This substance occurs in large quantities in the places examined by me. The area over which it is found is also large. It is not unlikely that the largest quantity of borax is in this form. Of this, however, I cannot speak with confidence, having dug into the soil only in isolated spots.

As ulexite is a soda-lime-borate, it was probably formed by the reaction of solutions of borate of soda and bicarbonate of lime.

3. *Sulphate of Soda,* or *Glauber Salt.* The area occupied by this material is close about the *salt area,* and almost surrounding it except on the west. It is reached by removing the surface earth and then the clay to a certain depth. It is then seen as a solid, transparent mass, like a subterranean ice cake. In some places it was so thick that we were unable to cut through it. This sulphate, of course, can be used in the manufacture of carbonate of soda, as in the well known Le Blanc process.

4. *Carbonate of Soda.* In one place only did I find carbonate of soda in condition sufficiently pure to be utilized. This was near the road leading from the salt vats to Mr. Rhodes' house. It was in the form of soft crust two or three inches thick, but how extensive the deposit is is not known. Carbonate of soda, whether native, or made from sulphate of soda, could, of course, be used in changing ulexite into borax. On the next page I have drawn a rough sketch (Fig. 11) of the marsh and of the areas of the various salts spoken of above. I hope you will understand, however, that this makes no pretensions to accuracy. It is intended only to make clear what I have written.

I know not if you desire my views as to the mode of formation of these several salts. In fact I have no very decided views. If the marsh is a simple dried up lake, the waters of which contained all these salts, then it would be impossible to account for the *localization* of the various kinds. The former lake, therefore, must have been supplied also largely by springs coming up in the lake bottom, and these springs brought up various kinds of salts, some one kind and some another. After the lake dried up, these springs still continuing to act would then commence to localize their products. This they are still doing. Thus I account for the localization of most of the kinds of salts. In addition to this, I think the common salt, as the most abundant ingredient of the lake water, was probably left everywhere as a crust, but subsequently was leached out, and accumulated in a very pure form in the lowest or central part. Of the manner in which the natural salt vats are formed I am not yet satisfied, but I think their rims are *built up* by water coming up through fissures and wetting these parts, and dust accumulating there because wet.

Yours, respectfully,

JOSEPH LECONTE.

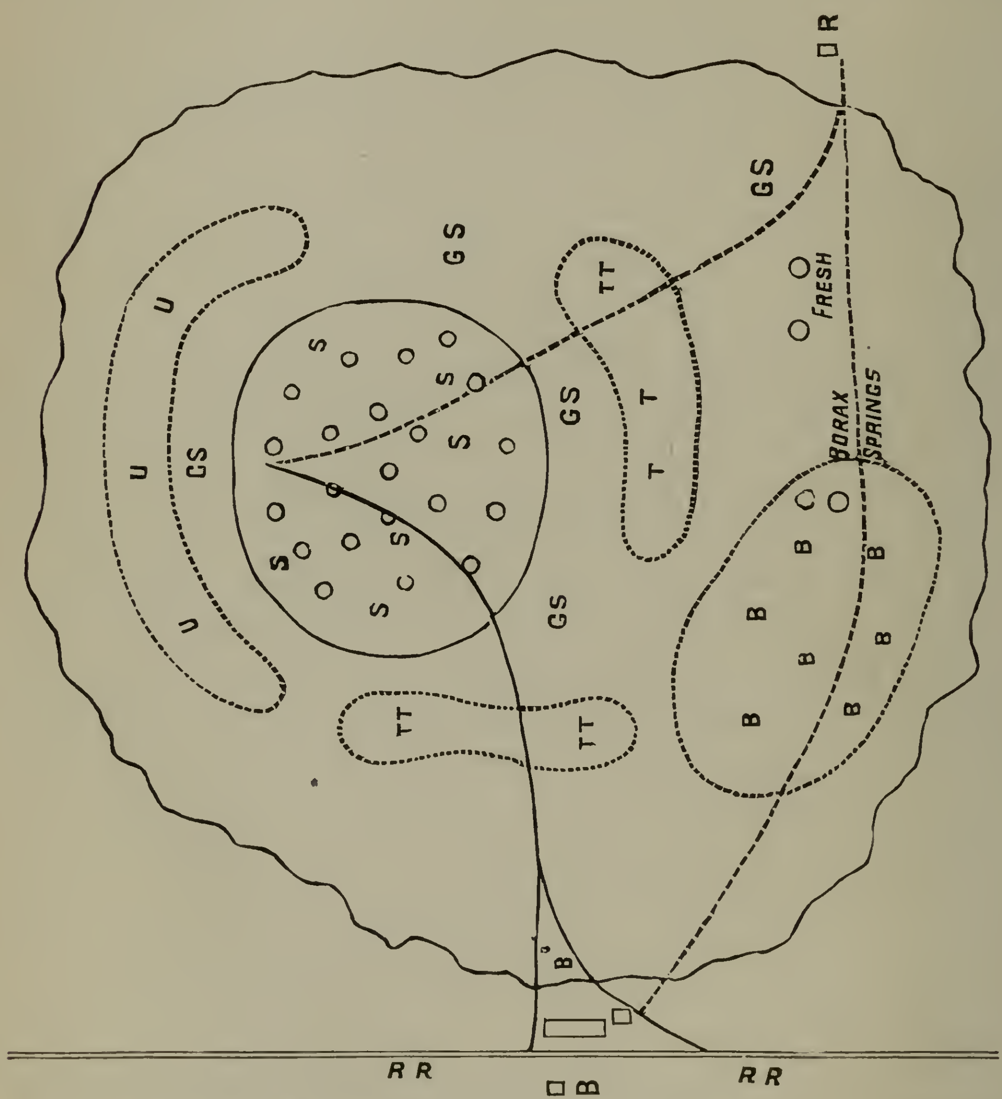

Fig. 11—*S. S.*—Salt vats; *B. B.*—Borax crust; *T. T.*—Tincal; *G. S.*—Glauber salt; *U. U.*—Ulexite; *O. O.*—Springs; *B.*—Rhodes' house; *B.*—Borax works; *C. S.*—Carbonate soda.

The following is the result of an examination of a sample of crude borax (tincal) from Rhodes' Marsh, made by me. The sample was furnished by J. R. Scupham, May, 1883. This material is an agglomeration of obscure crystals of anhydrous sulphate of soda (thenardite) in which are imbedded distinct and perfect crystals of borax; the whole covered with an efflorescence of a dirty white color, and intermixed with sand and fine gravel.

It has much the appearance of the crude borax from China, described by Fourcroy and quoted in this paper. When placed in water it softens, the borax crystals in a great measure separate, and may be picked out by hand. In experiments I made, I was able so to separate very nearly all the borax, which amounted to about nine per cent of the whole. These crystals ranged in size from half an inch to one tenth of an inch in length, and even less. They were nearly all perfect, with sharp angles and edges, and all prismatic, proving that they had crystallized from dilute solutions. Some contained mechanical impurities inclosed, while the larger portion were perfectly pure and transparent. After the borax crystals were picked out by hand, the remainder was dissolved in water by application of heat, and the sand filtered off. This was dried, weighed, and found to be seven per cent of the whole. The clear solution was returned to the clean dish, and evaporated to a pellicle, during which no insoluble precipitate formed. The dish was then set aside to crystallize. The result was a large quantity of very beautiful crystals of hydrated sulphate of soda, in which no crystals of borax could be seen. To make sure, the mother liquor was poured off, and the crystals dissolved in successive portions of cold water. No borax remained, which proved that the mechanical operation of picking out had been complete.

These experiments show that this form of crude borax material can be refined without difficulty, and that it contains about ten per cent of borax.

At the same locality, in the blue mud of the lake, large isolated crystals of borax have been found, exactly resembling those at Borax Lake, in California. Some of these were several inches in length, and all contain impurities included within the crystal. I dissolved one of these crystals and weighed the impurity, which was found to be eight per cent, and was fine desert sand.

COLUMBUS BORAX MARSH, ESMERALDA COUNTY,

Lies about one hundred and fifty miles southeast from Carson, and about the same distance from Wadsworth. It is an irregular oval in form, ten miles long by seven miles wide. It is the same locality at which Mr. Troop obtained the cotton balls from which he made the first borax. At one time there were four companies at work—the Pacific Borax Company, Hearn's Steam Works, and the others. I am not informed as to what is being done at the present time.

FISH LAKE, ESMERALDA COUNTY,

Is a small basin situated about twenty-five miles south of Columbus. I believe the only company now in possession is the Saline Valley Borax Company, W. D. Linton, Superintendent, who intended to prepare a description of the lake and the borax works, but his report was not received in time for publication. At one time Fish Lake Valley was the scene of great activity. In May, 1873, Mr. Nadeau projected large works. Mott & Piper were producing two tons of concentrated borax daily. Mr. Nadeau did a large business hauling the product to a market.

The Pacific Borax Company, incorporated under the laws of California, had works and locations at Columbus and Fish Lake. The first Trustees were Justinian Caire, Robert Morrow, M. M. Tompkins, and I. Lawrence Pool. Michael Kane was President. The company located 15,200 acres of supposed borax lands. Their principal works were situated five miles from Columbus. In June, 1872, they employed eighteen men.

PYRAMID LAKE.

The waters of this lake were examined by Mr. F. R. Waggoner and found to contain boracic acid. The following slip from a Nevada paper is given as an illustration of the extravagant construction some newspapers put upon a simple statement like the above. Similar publications have been made from time to time, which tend greatly to mislead the public and to impair confidence in legitimate enterprise.

BORAX FOR THE WORLD.

HOW A COMPANY OF CAPITALISTS PROPOSE TO MAKE LARGE PROFITS FROM THE WATERS OF PYRAMID LAKE.

Pyramid Lake contains one quarter of one per cent borax and one per cent carbonate of soda, or one pound of borax and four pounds of soda to every 400 pounds of water. Dr. F. R. Waggoner has had his eye on the lake for several months, and at last the object of his frequent visits to its shores have leaked out. How the doctor will like to have his pet scheme exposed we do not know, but having found out what he intends to do, the public gets the benefit of a reporter's inquisitiveness, and if anybody has any objection to Waggoner's project let them be recorded at an early day. Dr. Waggoner, it is said, has organized a company of capitalists to erect works and carry on the manufacture of borax on a very extensive scale. The company will be known as the "Pyramid Lake Borax and Desert Land Company," and it is their intention to apply to the Secretary of the Interior for the privilege of turning the course of the Truckee River into Mud Lake, thereby shutting off the source of fresh water supply from Pyramid Lake. There is already an open channel from the river at a point one or two miles from its mouth to Mud Lake, and about one third of the water empties into that lake now. After the river is turned the company proposes to evaporate the waters of Pyramid by solar evaporation. They calculate that in ten years the lake will evaporate 300 feet, or one inch every twenty-four hours. At the expiration of that time large borax works will be erected at the lake, and the water will be pumped into large zinc vats, and by artificial evaporation they will be enabled to supply the world with borax. It is the intention of the company to devote their time and a large amount of money to the reclamation of desert land made valuable by changing the course of the river, while waiting the process of evaporation. Hundreds of thousands of acres of desert land can be made into magnificent farms by this means. The proposition may seem a gigantic undertaking, and perhaps a little visionary, but nevertheless it is possible, and time and money is all that is required to carry it out.

LOCATION OF BORAX LANDS.

Deposits of borax may be located under the provisions of Title XXXII, Chapter 6, of the Revised Statutes of the United States, regulating the location of placer ground.

No one location made by an individual can exceed twenty acres, and no one location made by an association of individuals can exceed one hundred and sixty acres; which location of one hundred and sixty acres cannot be made by a less number than eight bona fide locators, and no local laws or mining regulations can restrict a placer location to less than twenty acres, although the locator is not compelled to take so much.

Where placer claims are upon surveyed public lands, the locations must be made to conform to legal subdivisions thereof as near as practicable.

The price to be paid for placer ground is five dollars per acre.

The following recent letter from the Secretary of the Interior to the Commissioner of the General Land Office, will be of interest to locators of borax deposits:

SECRETARY TELLER TO COMMISSIONER McFARLAND, JANUARY 30, 1883.

My attention is called to the fact that these deposits, although valuable, are not of sufficient value to permit their being entered under the mining laws. They ask whether the recent circular, approved by me September 22, 1882, and its amendment of December 9, 1882, is applicable to entries of lands containing borax and other similar valuable deposits.

It was early determined by the Department that the Act of May 10, 1882, which describes certain lands containing valuable mineral deposits, was applicable to land containing deposits of borax, carbonate and nitrate of soda, sulphur, alum, and asphalt; and I believe that from the passage of that law until the present time, the definition of the term, "valuable mineral deposits," has been such as to include the minerals and alkaline substances named. I understand that entries of borate lands have been allowed under the provisions of the Act of 1872, and the regulations made in accordance therewith.

It is the desire of persons interested, that the regulatious which were in existence having special reference to the applications for patents for placer claims, namely, the circular of October 31, 1881, should be continued in force, so far as they relate to deposits of borax, etc., as mentioned above. Believing that practical effect should be given to the mining laws of the United States, I am of the opinion that to apply the new regulations to such entries would result in excluding such lands from sale, and depriving the people of the benefit of the use of these natural deposits. I therefore direct you to permit the entry of public lands containing valuable deposits of borax, carbonate and nitrate of soda, sulphur, alum, and asphalt, in the States of California and Nevada and the Territories of Arizona and Wyoming, in which section of the country I am informed these deposits are present, under the regulations of October 31, 1881. In addition, however, an applicant for a patent for public lands containing deposits of borax, etc., as above, must affirmatively show that the lands entered are not valuable for any other purpose than the one for which the application is made. It will therefore follow that the circulars of September 22 and December 9, 1882, are not applicable to entries of the lands thus described and excepted. [*Copp's Land Owner*, Vol. 9, No. 11, February, 1883, page 210.]

CALIFORNIA AND NEVADA BORAX COMPANIES.

San Bernardino Borax Mining Company, S. Riddell, President.

Inyo Borax Company, of Inyo County, California; Greenland Salt and Borax Company, California; Amargosa Borax Mining Company, California, William T. Coleman & Co., Agents.

Teel's Marsh Borax Company, of Esmeralda County, Nevada, Smith Bros.

Pacific Borax Company, of Columbus, Nevada, F. M. Smith.

Nevada Salt and Borax Company, C. Van Dyck Hubbard, Secretary.

Saline Valley Borax Company, Fish Lake, Esmeralda County, Nevada, W. D. Linton, Superintendent.

Eagle Borax Company, Inyo County, I. Daunet, President.

BORACIC ACID.

Boric acid (English); acide borique (French); borsaure (German); acidum boracis, sal seditivum Hombergii, sal narcoticum vitrioli (Latin).

Names given to boracic acid by the old chemists: Flores boracis, sal volatile vitrioli, flores vitrioli philosophici, sal volatile narcotinum, sal album alchymistarum.

Boracic acid was discovered in 1702, by Homberg, a Dutch chemist, which he produced by subliming a mixture of sulphate of iron and borax.

Chaptal (Elements of Chemistry, London, 1808) describes Homberg's method of producing boracic acid, or the acid of borax, as follows:

When it is proposed to obtain it by sublimation, three or four pounds of calcined sulphate of iron and two ounces of borate of soda are dissolved in three pounds of water; the solution is filtered and evaporated to a pellicle, after which the sublimation as performed in a cucurbit of glass with its head. The acid of borax attaches itself to the internal surface of the head, from which it may be swept with a feather.

That the old chemists knew but little concerning the nature of boracic acid may be inferred from the following quotations:

FROM THE CHEMICAL WORKS OF CASPER NEUMAN, VOL. I, LONDON, 1773.

The mineral alkali appears from experiment to be a principal ingredient of borax. On treating borax with acids, about one fourth its weight of a peculiar saline substance (called sedative salt) is separated, and the residuum proves a combination of the alkali with the acid employed; thus, when the marine acid is used, a genuine sea salt remains; when the nitrous, a quadrangular nitre; and when the vitriolic, a sal mirabile. The substance separated joined to the mineral alkali, to the basis of sea salt, or to the salt of kali, recomposes borax again.

The properties of this substance so far as they are known, are these: It is of a bright, snowy whiteness, extremely light, composed of fine plates or scales, and as it were unctuous to the touch, of no smell, of a bitterish taste, accompanied with a slight impression of coldness.

It dissolves difficultly in boiling water, and on the liquor's cooling, crystallizes on its surface into thin plates, which uniting and becoming larger, fall to the bottom. It likewise dissolves, by the assistance of heat, in rectified spirits of wine; the solution set on fire burns with a green flame.

Moistened and exposed to a considerable heat, it in part sublimes; by repeated humectations the whole may be elevated. Whilst dry, it proves perfectly fixed; it melts, emits aqueous vapors, and runs into a vitreous substance, dissoluble again as at first; neither the glass or the salt itself are affected by the air. It makes no change in the color of blue flowers. It unites with the common alkaline salts, in some degree neutralizes, and renders them capable of crystallization. It is said to expel from alkalies every acid except the vitriolic, though expelled itself by every acid, from the alkaline basis of the borax.

* * * * * * * * *

The principal preparation of borax is a white volatile saline concrete, called *Flores boracis, sal volatile vitrioli, Flores vitrioli philofophici, sal volatile narcotinum,* and by some *sal album alchymistarum.* This is made sometimes with the *caput mortuum* of vitriol, and sometimes oil of vitriol. Three pounds of the *caput mortuum* or colcothar of green vitriol are elixated with six or seven quarts of boiling water, and the filtered liquor mixed with a solution of two ounces of borax in a quart of boiling water. The mixture suffered to settle for twelve hours, and poured off clear from the sediment, is evaporated to two pounds, or a quart, then put into a glass body and treated with a gradual fire; a fine sparkling sublimate arises, which, after the vessels have grown cold, is to be swept out with a feather. If the phlegm which comes over be returned on the residuum, a little more sublimate may be obtained, and thus repeatedly for a second and third time. The method of preparing the salt with oil of vitriol is, to dissolve two ounces of borax in a quart of water, gradually drop into the solution one ounce of oil of vitriol, evaporate about one third of the mixture, and then distill and cohobate as before. This salt was first discovered by Mr. Homberg, and is used by French physicians in fevers and ebullitions of the blood, in deliria, convulsions, hypochondriacal and hysterical affections. Its particular nature is as yet unknown; it has no volatile smell or pungent taste and appears to be of the neutral kind. I have prepared this salt by a more commodious method than that of Homberg, without sublimation or distillation. A solution of borax being mixed to saturation with a solution of alum the earth of the alum precipitates; the remaining liquor evaporated to a certain pitch and set to shoot, yields first fine crystals, the same with the sublimed flowers. If the process be continued, the crystals which shoot afterwards are found to be of a different kind.

FROM ELEMENTS OF NATURAL HISTORY AND CHEMISTRY, BY M. FOURCROY, 1790.

A diversity of opinion prevails concerning the nature and the formation of the boracic acid. A number of chemists have believed it to be an intimate combination of the sulphuric acid and a vitrificable earth with a fat matter. Messrs. Boudelin and Cadet think it to be formed by the muriatic acid. The latter of these two gentlemen thinks that it must contain a small quantity of earth of copper, because it has the same property with the oxides of copper, of communicating a green color to the flame of combustible bodies. Cartheuser assures us, that on drying and calcining by the action of a slow fire, a quantity of the boracic acid in a state of great purity, he observed it to emit vapors of muriatic acid, and on dissolving this salt thus dried, and filtering the solution, he found a gray earth remaining after the filtration; and, lastly, that by many repetitions of this calcination and solution, he at length accomplished the entire decomposition of the boracic acid, and found it to be a modification of the muriatic rendered fixed by an earth. This experiment has been repeated by Messrs. Maeguer and Poulletier de la Salle. They observed an odorous vapor to be disengaged during the calcination of this salt, but they were not able to distinguish from its smell that it was muriatic acid. By repeated desiccations and solutions they obtained a small portion of gray earth; but this earth when united with the muriatic acid, did not form sedative salt, as Cartheuser had given out, and of consequence this chemist's opinion appears to be no better supported than the rest. Model thought this salt to be a combination of a peculiar alkali with the sulphuric acid, which is used in disengaging it. But this opinion cannot be admitted, for the boracic acid is always the same, whatever be the acid to precipitate it. M. Baumé says that he found means to produce the boracic acid by leaving a mixture of grease and clay to macerate for eighteen months. At the end of that time he obtained from it by lixiviation a salt in small scales, with all the properties of *sedative salt.* From this he concludes the boracic acid to be a combination of the acid of grease with a very fine earth, which it is impossible to separate entirely from it. He adds, that the same salt may be produced with vegetable oils, but more slowly. M. Wiegleb repeated M. Baumé's experiment, but without obtaining boracic acid.

Chemists at present think this to be a peculiar acid, differing from all others, and possessing certain characteristics of its own. Its elective attractions with alkaline bases are arranged by Bergman in the following order: lime, barytes, magnesia, potash, soda, ammoniac. As they differ greatly from those of other acids above examined, they afford an additional proof of the peculiarity of the nature of this acid, whose compound principles remain still unknown." The use of the boracic acid in medicine was first introduced by Homberg, who ascribed to it quieting narcotic qualities, and gave it the name of sedative salt or volatile narcotic salt of vitriol; because he had obtained it by subliming nitre and vitriol. But experience has since shown the medical virtues of this salt to be but very moderate; at least it must be given in a much stronger dose than Homberg has directed, in order to produce the effects he ascribed to it; and it is very properly rejected, as we have many other medicines of the same class whose effects are much more certain.

The method of setting boracic acid free by sublimation and the use of sulphuric acid has been described. It is more conveniently obtained by dissolving borax in two and a half parts of boiling water and adding hydrochloric acid until the solution reacts strongly acid to test paper. Common salt is formed, and the boracic acid set free crystallizes out in thin shining plates, which retain water with considerable tenacity. The acid being but sparingly soluble in cold water may be purified by washing in that fluid, drying and recrystallizing from boiling water. When dried on clean bibulous paper, it becomes a beautifully white scaly powder, which, under the microscope, is seen to be in hexagonal scales, and in rouleaux of crystals, like blood corpuscles, or piles of coin.

When carefully prepared it is a most beautiful microscopic object, best seen on a dark field and lighted with a parabola. It may be recognized under all circumstances when its appearance has become familiar to the observer.

Fig. 12—Boracic acid crystallized from solution, as seen under the microscope magnified 21 diameters. Drawn with the camera Lucida. (*A*) Rouleau of crystals.

PERCENTAGE COMPOSITION OF BORACIC ACID.

Boracic acid	56.4
Water	43.6
	100.0

CHEMICAL EQUIVALENT.

Boracic acid	35.03
Water	27.00
	62.03

Boracic acid is soluble in 27 times its weight of water at 60°, and in 2.96 parts of water at 212°. The hydrated acid dissolves in alcohol, which burns with a characteristic green flame, seen even in the presence of soda salts, which impart a yellow color to the flame. But if soda is largely in excess, the green color is masked, and can only be observed when the alcohol is nearly consumed, and the distinguishing color is more marked if the expiring flame is gently agitated by breathing upon it, but under these circumstances a good eye is required to distinguish the color. By far the best color test is made by the use of the direct vision spectroscope, which shows three distinct pale green bands in the green part of the spectrum. I have used the beautiful little instrument made by Browning, of London, and which is shown in figure 13:

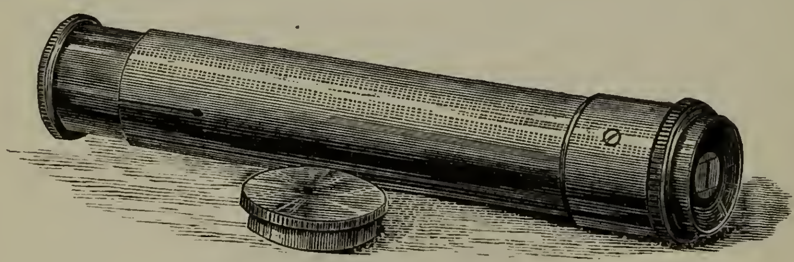

Fig. 13.

The use of this instrument is simple, and once seen is easily understood and practiced. The substance supposed to contain boracic acid is placed in an evaporating dish, and a few drops of sulphuric acid added. A brisk effervescence generally takes place. The contents of the dish must be stirred, which may be done with a small stick, or anything convenient at hand. Alcohol is then poured in, in small quantity, and ignited. All that is then required to determine the presence of borax or boracic acid is to look at the flame through the spectroscope. Three distinct and beautifully green bands will be seen if boracic acid is present.

If *free* boracic acid is contained in the sample, the green bands may be produced without the introduction of sulphuric acid. It is best, however, always to use the acid, which decomposes the salt containing the weaker boracic acid, and to make a secondary test to prove the boracic acid to be free or otherwise.

The experiment should be made in a dark room. The bands are best seen when the slit is so far closed as to show the sodium band, always present, as a very narrow line. Figure 14 shows the bands of boracic acid as seen in the spectroscope.

Fig. 14—Spectrum of boracic acid; the yellow is the sodium band always seen.

With the spectroscope, a bottle of strong sulphuric acid, one of alcohol, and a small evaporating dish, the prospector, although unskilled in chemical handicraft, may detect with unerring certainty the presence or otherwise of boracic acid or any of its salts in the deposits he may find.

When boracic acid is suspected in steam issuing from hot springs, it is only necessary to condense a portion of the steam. The resulting water is evaporated nearly to dryness at a *very gentle* heat; alcohol is then added and the flame examined as before. This test shows the presence of boracic acid in the waters of Mono Lake, and in the eruptive mud from the mud volcanoes of the Colorado Desert, San Diego County.

The only weak point in this determination lies in its extreme delicacy. In inexperienced hands it might lead to the hope that the sample was rich when boracic acid was present only in small quantities; but a little experience will correct this, for it will be seen that when the quantity is small the bands are faint, and come and go in an intermittent manner; while, if the quantity is large, they are distinct and well defined, and the color a clear green. As with the sodium band, the intensity of the color is an index to quantity—all of which may be learned by experience. In making this determination all bands of other substances present, as lithium, potassium, etc., must be disregarded.

In prospecting the deserts, there are no facilities for chemical operations, and the prospector, generally poor, can but ill afford to send his samples to San Francisco, or pay the cost of chemical analysis. These considerations have no doubt retarded the development of the borax interests of the State.

It is sometimes inconvenient to use alcohol in the manner described. The experiment can be made with equal facility in the flame of a Bunsen gas burner, or spirit lamp.

The substance to be examined is supported in a loop of platinum wire. The wire may be held in the hand when the color is to be observed by the unassisted eye, but when the spectroscope is used it must be supported. A convenient support may be improvised in the following manner: A small glass funnel is placed on the table with the tube part upwards. A glass rod or wire small enough to pass easily into the tube, is cut to a convenient length, wrapped with paper, and pushed into the tube of the funnel. The paper acts as packing, and when arranged the rod may be raised or depressed by pushing up or down in the tube. A common cork, of medium size, is pierced with a cork borer diametrically, and placed on the rod. A wire is thrust through the cork at right angles with the vertical rod. This wire may be three or four inches in length.

A small glass tube may then be selected and cut to the length of an inch and a half. One end is closed in the blowpipe flame, and a short piece of platinum wire inserted while the glass is still hot; when cold the wire will be firmly set in the closed end of the tube; the other is open. In the end of the platinum wire a small loop is made; when all is ready the substance is ground in an agate mortar with a small excess of a mixture of equal parts of bisulphate of potash and fluorspar. The platinum wire is first held in the flame for a moment to see that it is clean and gives no color. The flame is examined to be sure that no color is imparted by any uncleanness of the burner. If the flame is blue, and perfectly non-luminous, it may be observed through the spectroscope, and if no color is seen except the bright yellow sodium band the apparatus is ready for use. To make the experiment, the Bunsen burner is lighted, and a full head of gas turned on, making the flame five or six inches long. The glass tube with its platinum wire and loop is slipped off from the horizontal wire, and the loop dipped into a small vessel of distilled water, and then into the mixture in the agate mortar. The tube is then replaced on the wire, and the whole stand pushed near the flame with the loop and the assay about half an inch above the top of the burner. The spectroscope is then held to the eye in the left hand, while the stand is gently pushed with the right until the substance to be examined touches the flame. The green bands will instantly appear if boracic acid is present. This description will be fully understood by a glance at the following engraving:

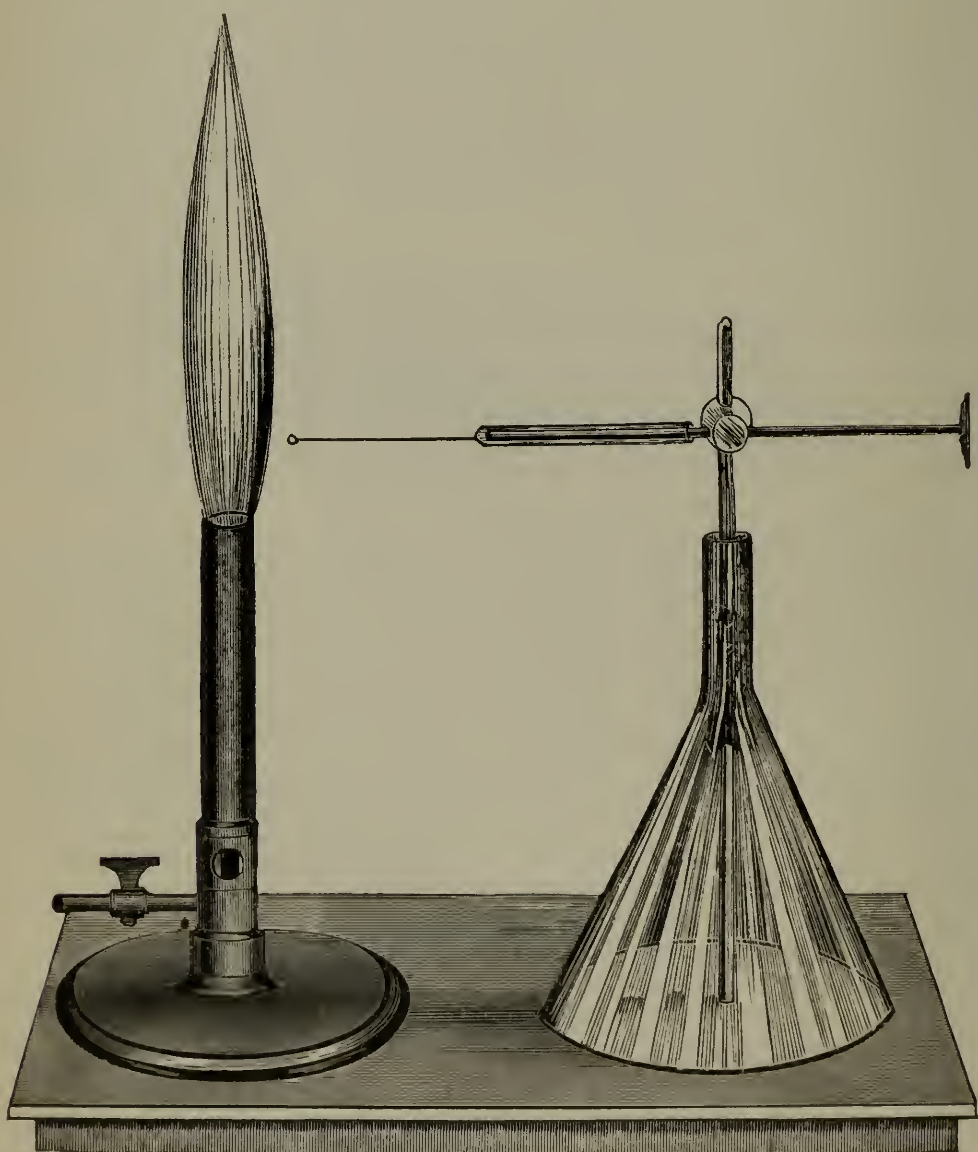

Fig. 15—Apparatus for observing the green color of burning boracic acid, scale ½.

Bisulphate of potash is prepared by placing a convenient quantity of powdered sulphate of potash in a porcelain capsule and wetting it with concentrated sulphuric acid. The mixture must be heated until no more white fumes are given off, and a small portion taken out on a glass rod cools into a hard coating. The heat employed must be sufficiently great to keep the mixture in a state of fusion until the excess of acid is driven off. When cold, the mass must be pulverized and kept in a glass-stoppered bottle for use.

NATIVE BORACIC ACID

Is known to the mineralogist as Sassolite, or Sassoline, named from Sasso, in Italy, where it was first found in a solid state by Mascagni. It occurs also abundantly in the extinct crater of a volcano in one of the Lapary Islands, near Sicily, as mentioned elsewhere, at which locality it was discovered in 1813 by Dr. Holland. It is found, also, in crevices and fissures in the craters of active volcanoes. During the eruption of Vesuvius, in 1851, this mineral was found in fissures in Torre Del Greco. It has been obtained, also, from the crater of Stromboli, an active volcano on an island of the same name, one of the Lapari Group. It exists, also, in solution in mineral waters of Germany and elsewhere, notably Wiesbaden, Aachen, and Krankenheil.

Boracic acid, free or combined, is of common occurrence on the Pacific Coast. It has been found in the waters of the ocean along the shores of California and Oregon. Common salt, made by evaporating the sea water, contains more than traces of boracic acid. According to Professor W. P. Blake, it occurs in a free state in the water of Clear Lake. The discovery of this acid in mineral water in Tehama County led to the examination of other springs then known, which resulted in the finding of boracic acid in nearly all of them. It was discovered at the mud volcanoes in San Diego County by Dr. Veatch, which was verified by my own observation. An account of this interesting locality will be found in the second annual report of the State Mineralogist, folio 227.

Sassolite, of the books, is said to crystallize, in the triclinic system, but all the specimens I have seen show under the microscope a confusion of broken scales without any well defined crystals. When magnified it has almost exactly the appearance of selenite, with the same apparent cleavage and pearly luster. When closely examined, obscure hexagonal plates, imbedded in the pearly mass, may sometimes be distinguished.

Sassolite fuses easily, coloring the blowpipe flame at the same time transiently green; gives water in a closed glass tube; color, white-yellowish, and sometimes a dirty brown; hardness, 1 to 1.48; chemical formula, BO_3+3HO.

PERCENTAGE COMPOSITION.

Boracic acid	56.45
Water	43.55
	100.00

SOLUBILITY OF CRYSTALLIZED BORACIC ACID IN WATER.

Temperature.		Solution in parts of water.	One hundred parts of water dissolves—	Saturated aqueous solution contains per cent $BO_3 + 3HO$.
Centigrade.	Fahrenheit.			
18.7	65.7	25.66	3.9 parts	3.75
25.0	77.0	14.88	6.8 parts	6.27
37.5	99.5	12.66	7.8 parts	7.32
50.0	122.0	10.16	9.8 parts	8.96
62.5	144.5	6.12	16.0 parts	14.04
75.0	167.0	4.73	21.0 parts	17.44
87.5	189.5	3.55	28.0 parts	21.95
100.0	212.0	2.97	34.0 parts	25.17

Boracic acid was discovered in a natural state in Italy in 1777, by Hœffer, chemist to the Grand Duke of Tuscany.

The following extracts from the works on the geology and mineral resources of Central Italy, by W. P. Jervis, Conservator of the Royal Museum of Turin, Italy, may be accepted as full and reliable. Not only a history is given, but also the details of the manufacture:

In 1742, Targioni Tozzetti, a scientific Tuscan traveler, visited the salt works of Volterra in his rambles through the Maremme, and proceeded southward through Pomarance to Monte Cerboli, in order to examine the curious phenomenon of hot vapors which abounded in the neighborhood. He relates how he took a stroll through the valley which stretches southeast from Monte Cerboli, and reached the little torrent Possera. All around him was a scene of desolation, well fitted to strike dismay on the ignorant, but eminently suited to the contemplative mind of the naturalist, to whom the most dreary plains and barren rocks yield ample subject for useful and agreeable study. His attention, however, was soon attracted to the scene around him. He stood close to a yawning gulf, from which issued rumbling noises and disagreeable odors. He wished to look down and peep into the mysterious chasm to learn something of its nature, but his temerity was rewarded by a surly growl from within, and his guide told him that the noise sometimes resembled a hundred bellows, as if Vulcan himself were at work, while flames issued forth at night after very hot days. Though he saw no fire, the vapors served as a warning to keep him at a considerable distance; but before long he came upon more vapor vents, *soffioni*, and the little *lagoni*, or ponds of muddy blue water, boiling vehemently, the imprisoned gas producing bubbles, increasing in size till sufficiently large to cause them to burst. Dense white vapors, smelling strongly of rotten eggs, rose from the *lagoni* and ascended to a considerable height into the atmosphere. The ground on which he stood was soft and crumbled under his feet; the decomposed rocks, and some of the efflorescent minerals, were new to him, and the subject of many curious speculations. The whole of the valley was apparently studded with such lagoons, an attempt to define the number of which was futile, connected, as they were in many places, by cross fissures and superficial cracks. Not a tree was visible throughout the whole extent of the valley. The opening of a new fissure was the signal for the destruction of all neighboring shrubs, scorched by the subterranean heat. Occasionally, he was told, the *lagoni* would be overcharged by the rain, and their contents flow into the Possera, where the heat would kill all the fish for a considerable distance down its course, the density of the atmosphere in cloudy weather pressing on the columns of vapor, causing them to lie more close to the ground and spread themselves horizontally, while the grumbling sounds in the bowels of the earth redoubled in fury. Passing on toward Castelnuovo, the same lagoons were abundant, but of smaller dimensions, and according to tradition, they were on the increase; on the other hand, old lagoons dried up, only emitting steam at intervals.

A farmhouse near Castelnuovo, built 200 years before, had been suddenly undermined, a *fumacchio*, or incipient lagoon, having unceremoniously made its appearance in the kitchen, rapidly assuming the dimensions of a true lagoon. The inhabitants were utterly defenseless, and bade adieu to their ancestral tenement, the stone walls of which were soon attacked by the corroding influence of the vapors, and speedily destined, as our traveler truly predicted, to crumble to pieces. Within certain limits fertile fields were subject to be laid waste, and poisonous gases escaped, which had on several occasions proved fatal. Thus he relates how a swineherd in charge of forty pigs had been overtaken by the noxious gases; all the poor animals were killed but one. Another man, who was working in an alabaster pit, was suddenly overpowered by the escape of mephitic gas through the marls, and cried loudly for help to his fellow at the mouth of the shaft. While he was being hauled up he was stifled by oppression of the lungs, and fell lifeless to the bottom. Should any luckless wight approach the lagoon too closely, he would stand the chance of sinking into a quagmire or losing a leg. Sheep occasionally fell victims when rushing too carelessly along, and after remaining a short time in the water, nothing but a bleached skeleton remained. Though this picture is perhaps rather overdrawn, the temperature being very considerably above the boiling point of pure water, very serious and generally fatal accidents must have resulted. It would be untrue to say that the *soffioni* were utterly useless. The skilled peasants would cleverly manage to roast their chestnuts in sacks placed over these vapor vents; no small convenience in a country where this article is a substitute for bread. Birds, game, and cattle make the *lagoni* their winter resort, in order to escape from the cold, snowy ground. The latter, indeed, occasionally frequented the neighborhood to rid themselves of gadflies and mosquitoes.

Our traveler traced the vapors principally along the course of the rivulet, where they found their way out from beneath huge masses of rock. In their vicinity a hole made with a stick would frequently originate a little pool, or *lagoncello*, from whence sulphurous vapors poured forth. As to the noxious vapors, which are nothing but carbonic acid gas, he was told that the introduction of a copious supply of water into the vents destroyed their power. * * *

In 1777, Hœffer, the chemist of the Grand Duke of Tuscany, found boracic acid at Monte Rotondo and Castelnuovo; a fact confirmed two years subsequently at Monte Rotondo by Professor Mascagni, well known for his researches on the lymphatic system.

Gazzeri made some attempts to utilize the boracic acid in these waters in 1808, and again in 1816. Hœffer and Mascagni proposed to make borax from them—the latter in 1812. Mascagni, however, was too much engaged in his scientific labors to carry out this idea, for which he even obtained a patent during Napoleon's rule in Italy. He therefore ceded his right to Fossi, to whom he communicated his proposition for placing cauldrons of the solution of the acid in the lagoons, as in a water bath, in order to concentrate it.

Fossi was the first to obtain boracic acid in any quantity from Monte Rotondo, and I find from the *Atti dei Georgo fili*, tome xvii, Firenze, 1839, that he exhibited white glass in Florence as early as 1818, prepared from borax made from the lagoons.

Messrs. Gazzeri and Brouzet worked the lagoons of Monte Rotondo from 1815 to 1818, employing as their engineer Signor Ciaschi, who made further improvements by constructing artificial lagoons around the dry *soffioni*, to utilize the hitherto waste vapors. The poor fellow was one day superintending an operation of this nature, in 1816, when he fell into a fissure. He was dragged out half dead, and only lingered for a few days, during which time he suffered the most excruciating torture from violent spasms and frightful burns.

Gazzeri and Brouzet, with great difficulty, managed to export to France three tons and five and a half cwt. of very impure crude boracic acid in the nine and a half months ending April 1, 1818. * * * Thus, for forty years, little or nothing was done, when in 1818, M. François Lardarel, a French gentleman then staying in Tuscany, resolved on the formation of a small establishment for the collection and extraction of the boracic acid. For many years his labors were attended with small success; the sale of the acid was steady, but the profits were inconsiderable. He was thus induced to study a more economical means of evaporation; the expense of firewood for that purpose, up to 1827, having swallowed up the greater part of his proceeds, the more so, as it was particularly scarce in that neighborhood, where not a blade of grass was to be seen, and road communication for bringing it had all to be made by the proprietor of the works.

After much thought, the brilliant idea struck M. Lardarel, that by some method he might take advantage of the natural steam jets or *soffioni*, arising so plentifully from the soil, and at the period I have mentioned he devised the means of imprisoning them and turning them to account, which I shall describe. The process was a triumph for those days, when, let us remember, steam was little known as an element in manufacturing industry. From that moment, the produce of the works rapidly increased, and the uses to which the boracic acid was applied became equally numerous.

At the present time there are no less than nine separate establishments belonging to Count Lardarel, all situated within a few miles of Castelnuovo (Leghorn), a little town between Volterra and Massa Marittima, viz.: Lustignano, Lardarello, Lago, Saso, Monte Rotondo, Serrazzano, San Federigo, San Edoardo, and Castelnuovo.

M. Duval has one establishment at the Lake of Monte Rotondo, and a new company has been established at Travale, near Volterra. All these places are in close proximity to eruptions of *Gabbro* or Miocene Serpentine.

* * * * * * * * * * *

The works are so similar that it will only be necessary to describe in detail that of Lardarello, which is highly interesting. This thriving little colony is entirely the creation of Count Lardarel, and is situated on the torrent Possera, below the village of Monte Cerboli, three miles from Serrazzano and six from Pomarance. A group of half a dozen or more *lagoni* are seen on the slope of the hill about half a mile from the main road, from which they are completely hidden by rising ground. Some of these *lagoni* are those described by Targioni Tozzetti, but the vapor vents—the *soffioni* of which he speaks—no longer exist, as they have been artificially converted into *lagoni*.

Singularly enough boracic acid has never been found in the solid state at any depth to which search has been made, with the exception of such places in which it has sublimed. It is probably either the result of double decomposition of water and a volatile salt of boron; according to Dumas' theory sulphide of boron and water producing boracic acid and sulphuretted hydrogen, thus: $Bo\ S_2 + 2\ HO = Bo\ O_2 + 2\ HS$, or simply a chloride of boron and water producing boracic and hydrochloric acids, thus: $Bo\ Cl_2 + 2\ HO = Bo\ O_2 + 2\ H\ Cl$. In support of which supposition we only find the boracic acid appear when there is water present, or it may be caused by the reaction of sulphuric acid on borates, such as tourmaline, the granite found not very far off being so rich in this mineral as to bear the name tourmaliniferous granite. The theory I advance is tenable, provided we assume the heat to be very great. Though sulphuric acid is one of the most powerful and boracic acid the weakest, next to carbonic acid, at ordinary temperatures, they exhibit the reverse phenomena at very elevated temperatures; in fact, boracic acid, under such circumstances, will actually decompose sulphates formed by the action of sulphuric acid on borates. Before water is introduced into the fissures they are mere *soffioni*. Borates of the several bases are probably abundant at great depth and are uninjured by the continual passage of sulphurous vapors, and even sulphuric acid, on their way to the surface, whence the latter escape, but boracic acid is not to be detected. Water being now introduced lowers the temperature and the balance of affinities is altered, the powerfully corroding influence of the sulphuric acid on the borates is set in operation, whence the boracic acid is liberated and ascends in solution with the ejected water and steam.

The following is the analysis of the gases issuing from a *soffioni*, examined by Payen:

Carbonic acid	57.30
Nitrogen	34.81
Oxygen	6.57
Sulphuretted hydrogen	1.32
	100.00

Respecting the temperature of the fissures, none have satisfactorily treated the question, though it has attracted much attention from Pilla, Murchison, Lardarel, etc.

I think that some light is thrown on the subject by the presence of an instructive mineral round the lagoons, viz., anhydrite (CaO, SO_3), evidently formed at a temperature at which water could not combine with the sulphate of lime to produce ordinary gypsum. When gypsum (CaO, SO_3+2HO) is heated to 260° Fah. it loses its water of crystallization, and becomes plaster of Paris, but on cooling it absorbs the original quantity of water. When it is heated to redness this does not take place, but the mass melts into an enamel, which, according to Regnault, is identical with anhydrite. The heat on the other hand could not have been much above redness, provided my theory of borates is correct.

The first care of the manufacturer is the removal of a certain quantity of the clay and the formation of a *lagone*, or basin of more or less circular form, the sides of which have to be strengthened by rough stones to prevent them from falling in, the tenacity of the clay sufficing for the bottom. The usual depth of a *lagone* is from four to six feet, more rarely as many yards. The capacity and depth have to be regulated with the utmost care, according to the force of the vapor in that particular vent. During the period that the workmen are employed in digging a *lagone* the steam is conveyed away into the atmosphere above their heads by means of a tall chimney, which protects them from being scalded.

A stream of water has been brought to the uppermost lagoon at Lardarello, from near the Bagno del Morbo, not a quarter of a mile off. This lagoon is about fifteen or twenty yards in diameter, with a jet of steam in the center, forcing its way through the fissure by its specific gravity; the water comes in contact with the highly heated gases and rocks, and is immediately converted into steam, which, from its elasticity and enormous increase in volume, is ejected with great force, but is condensed as soon as it reaches the surface of the basin by the colder water around. This incessant vaporization of the water, and its subsequent liquefaction, produces a great commotion in the lagoon, a turbulent little fountain rising to the height of a foot, causing a succession of concentric ripples; all this time there is a copious discharge of sulphuretted hydrogen, which in one case I distinctly perceived in the night time full a quarter of a mile from a lagoon and before I knew of its existence there.

Having remained twenty-four hours subject to continual agitation, the water, which has become of a slate-blue color, is let out of the lagoon and passes into a canal, through which it is conducted into a second basin at a lower level; thence it passes through several more, each lower than the last, though of similar construction.

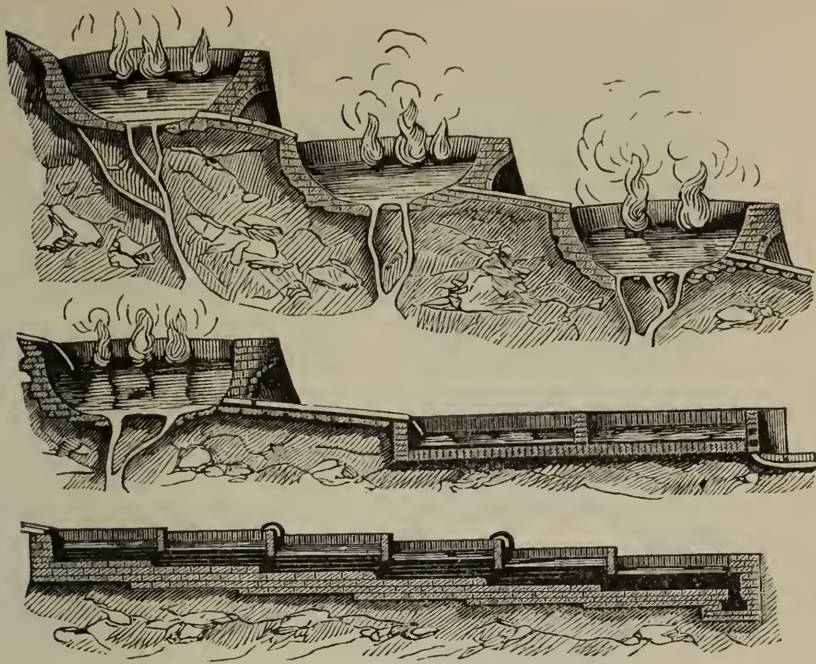

Fig. 16—Artificial Lagoons and Evaporators.—*Regnault's Elements of Chemistry.*

In this manner the water dissolves the boracic acid in the fissures, and brings it up mechanically mixed with it. No other object appears to be attained by making all the water pass through the chain of *lagoni,* than to obtain boracic acid of uniform density, though Dumas expressed to Count Lardarel the opinion that probably by some ingenious device, it might be brought to a saturation of fifteen to sixteen per cent—a great desideratum. The temperature of the liquid is considerably above 212° Fahr., and dense vapors rise for many yards above the ground, heating the air so much as to render it unpleasant to remain long near them. Efflorescent minerals and decomposed rock ejected by the steam, lie scattered all round the heated surface of the ground, along with sulphur incrustations, and many sulphates, such as gypsum-alum, and sulphate of ammonia, besides iron pyrites in minute veins in the fragments of rocks.

The water passes at stated intervals into the vasco (*A*, Fig. 17), a tank sixty feet square, which is covered by a tiled roof supported at the sides with slight brick pillars. Here the greater part of the mechanical impurities, clay, and the more insoluble sulphates, sink to the bottom, and the water regains its limpidity. The next operation is to concentrate the solution of acid, which is effected in the adjoining buildin gcontaining the evaporating pans (*B*, Fig. 17).

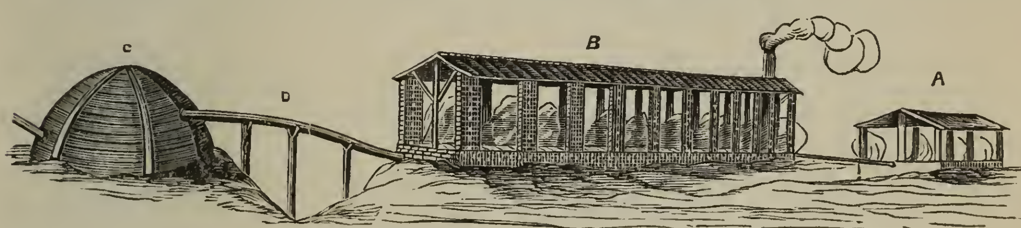

Fig. 17—Adrian Evaporators, Vasco, and Steam Dome—Jervis.

These are so exceedingly ingenious and simple as to merit particular consideration. Count Lardarel, who invented them, has given them the name of *Adrian Evaporators*. Three parallel series of shallow leaden divisions, called *Scanelli,* are placed in a line, each being a third of an inch below the one before it, from which it is only separated by a leaden partition half an inch broad and as deep. The *scanelli* are placed transversely, and are six feet long by twenty-two inches wide. They are arranged under a roof to keep off the rain, and the evaporation is not in any way impeded, since the sides are open, and only a few brick pillars of the lightest construction are employed to support the roof. The length of the building is often several hundred feet.

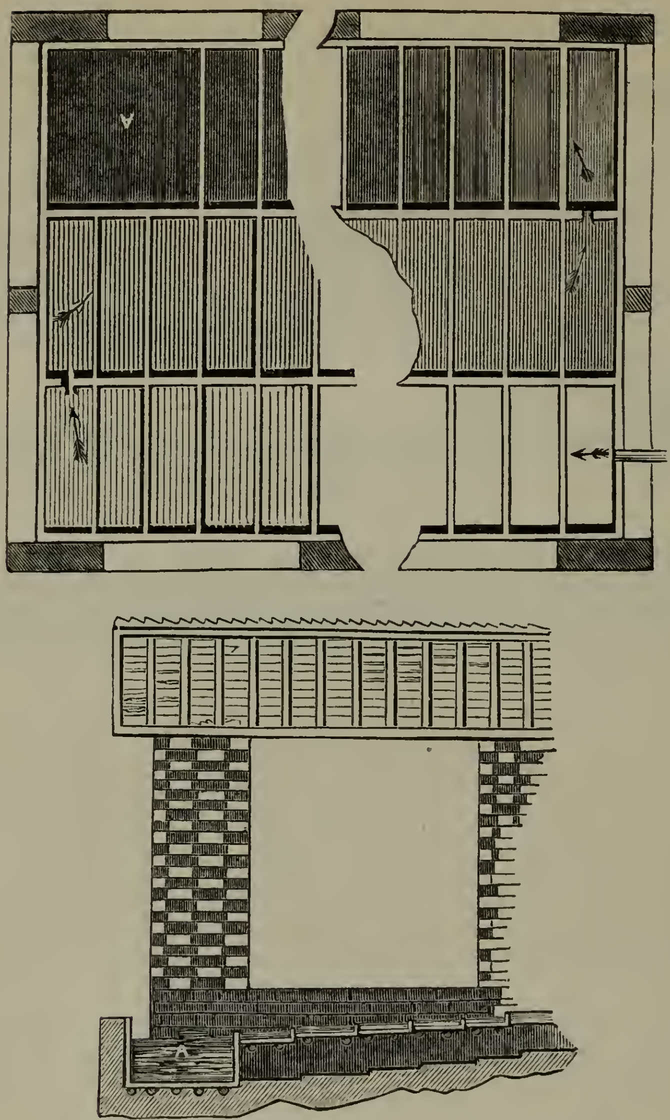

Fig. 18--Adrian Evaporator in plan and section—Jervis.

At the commencement of the operation a man turns a tap, which lets the water flow in regulated quantities from the vasco into the first *scanello*. Everything depending on this precaution, it now flows on from one division of these diaphragm pans to another, until arriving at the bottom of the building it passes along the second row of divisions, and finally back through the last series into the diagonal corner, where there is a deep reservoir, called the *Caldaja a sale* (*A*, Fig. 18). In its progress the water gradually evaporates, as mentioned before. It only contained one and a half to two per cent of boracic acid when it entered the building, but after having passed through fifty or sixty divisions, it assumes a decidedly yellow tinge, increasing in intensity until it becomes a bright golden yellow fluid, having a characteristic odor.

The interior arrangements of the evaporators, though they may appear simple enough, were the result of much thought. The leaden pans are supported by beams over a low vaulted steam passage, lined with hydraulic cement, to protect the stonework and to keep in the heat. For this purpose a *soffione* is vaulted over with a stone dome about ten feet high, firmly bound with wrought iron bars (*C*, Fig. 17). Water is admitted, and the imprisoned high pressure steam, thereby produced, acquires immense power, and thumping loudly against the dome, the jets of water seem ready at every moment to undermine the structure. The steam now passes through the vaulted passage into the lower chamber of the evaporators, and having traversed it from end to end, finds its way out into the open air through a chimney at the opposite end.

What formerly took sixty-two hours to evaporate is performed by this beautiful contrivance in twelve, the expense being also proportionably diminished.

From the *caldaja a sale* the syrup liquor is periodically conducted along a wooden pipe to the *bollajo*, or crystallizing house, in which a series of large barrels (tonne), three or three and a half feet in diameter, are arranged in a line.

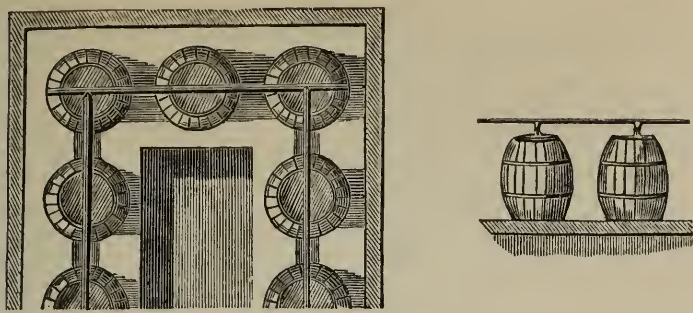

Fig. 19—Crystallizers.

When it is desired to fill them, all that is necessary to be done is to remove a plug placed over the center of each barrel, which runs round the building. The liquor remains four days in the barrels, during which time it has crystallized at the sides and bottom to the thickness of several inches. The liquid portion is then withdrawn by removing a plug, and finds its way along a longitudinal drain, by which means it is all saved for future use. No one could fail to admire these beautiful processes, whose characteristic merit is that they do not necessitate anything being lost.

The boracic acid crystallizes in hexagonal plates, about the size and thickness of a wafer, having a flaky appearance and pearly luster. From their form they naturally retain much water, mechanically mixed, so that they are first put in large wicker baskets (*Corbelli*) to drain, and then emptied on the floor of a large airy chamber, called the *Asciugatojo,* or drying house.

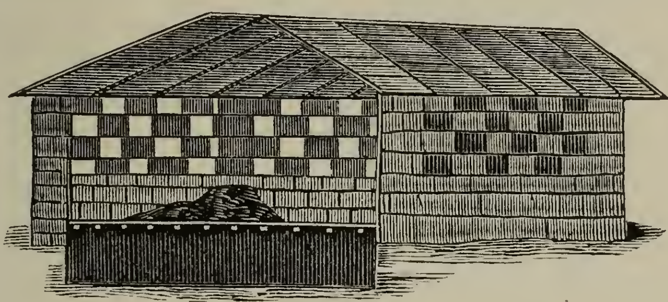

Fig. 20—Drying House.

The brick floor is heated like the evaporators, by steam passing through an underground chamber. The boracic acid being spread out in thin layers on the floor, is stirred from time to time with a wooden rake, and the crystals, while losing their sharp angles, separate in a great measure from each other. When dry, nothing remains to be done but to shovel up the mass of crystals and to remove them to the warehouse, where the produce of all the establishments is mixed, to insure its being all of uniform quality. It is then put in large barrels, containing 2,000 Tuscan pounds, or thirteen and a half cwt., and conveyed to Leghorn, whence the greater portion is exported to England. * * * *

The first impression produced on my mind after having gone through the whole establishment, was the marvelous simplicity of the successive processes. Almost everything being performed by Nature, little has to be effected by human agency but to convey the water to the *lagoni,* and to regulate the supply in the various operations; to empty the barrels and spread the crystals on the floor to dry. Such is the work allotted to the forty men who are employed at Lardarello on ordinary occasions. They commence at 4 A. M. in Summer, and at sunrise in Winter, and work on an average only four or five hours daily; thus I arrived at 10 A. M., but they had finished for the day. The art of producing boracic acid is, however, very harrassing. Sometimes the sides of a lagoon break in, or there is not sufficient water; perhaps through carelessness on the part of the men the steam supply diminishes at a particular spot, as is liable to occur unless they regulate the quantity of water accordingly. The inevitable consequence is that the lagoon becomes useless, and the steam seeks an easier vent for itself elsewhere. In some cases it forms a new *soffione* a hundred yards off, or else, unable to force an immediate passage to the surface, it is needful to have recourse to boring, and a perfectly new lagoon is constructed. This operation is by no means an enviable task. The ground feels so hot near fissures which do not quite reach the surface, but from which the steam issues in minute jets, that I had my feet scorched through a very thick pair of shoes, and one is warned to retreat, since a few steps further on would probably cause one to sink into a hidden cauldron or steam bath. Around this place are fragments of *alberese* limestone, the gradual metamorphoses of which are very visible. First, the rock, which has a dirty brown discoloration, is shivered and rendered friable; and in other places actually converted into gypsum, as has been described by

Savi and Meneghini. Besides these, there are clays and marls of the Eocene, Miocene, and Pliocene formations. The boracic acid works of Lardarello are figured in the frontispiece.

The boracic acid crystals are far from being pure, containing a small quantity of numerous sulphates mechanically mixed. In 1842 *Wittstein* published the following analysis:

Crystallized boracic acid	76.494
Sulphate of iron	0.365
Sulphate of alumina	0.320
Sulphate of lime	1.018
Sulphate of magnesia	2.632
Sulphate of ammonia	8.508
Sulphate of soda	0.917
Sulphate of potash	0.369
Chloride of ammonium	0.298
Water of crystallization	6.557
Silicic acid	1.200
Sulphuric acid mixed with boracic acid	1.322
Organic matter and sulphate of iron	traces.
	100.000

The amount of foreign salts has considerably diminished since the *lagoni* were first made use of. In order to purify the crude product, which is not done in Tuscany, nothing further is necessary but to crystallize it once or twice.

The following letter from W. P. Jervis was received by the State Mineralogist in answer to one of inquiry. While it contains some repetitions of the foregoing quotation, it at the same time makes some corrections. It is given entire, for the reason that the connection would be broken if any portion was omitted:

Turin, June 24, 1882.

Mr. Henry G. Hanks, *State Mineralogist of California, San Francisco*:

Dear Sir: I have received your letter of May fourth. Only these last two or three days I returned from Rome. Now I inclose you the translation of the principal remarks I made on the geological origin of the boracic acid in the lagoons of central Italy, as contained in my great work "I Tesori Sotterranei Dell Italia," Vol. 2. You will perceive that since writing the "*Mineral Resources of Central Italy*" I have altered my opinion most fundamentally regarding the theories formerly held universally about the volcanic origin of these lagoons. I therefore request you, in perusing the volume in English alluded to, to bear in mind these new deductions. It is of material consequence, in order not to continue to regard these localities as connected with volcanic phenomena of which there is not only no proof, but direct evidence to the contrary.

As to the *technological* part, that is quite accurately described in the Mineral Resources, and the drawings and sections may be said to be just what I would now repeat.

In my book, the "Guida alle acque minerali d'Italia," a general view of the boracic acid lagoons of Lardarello and Pomerance is given with the domes, canals, etc.*

Please not to misunderstand me. Boracic acid also exists in Italy in quiescent (not extinct) volcanoes at Vulcano in the Æolian Islands. (See "Tesori Sotteranei," volume 3, page 199.) It is quite a different thing from what is found in Tuscany, much as I thought originally it was all due to one cause. True, the association of minerals in both places is very remarkably similar. Probably the boracic acid of California has more analogy with that of Lipari (Vulcano) than with that of Pomerance and the neighborhood.

Boracic acid is produced in Central Italy on a vast scale in the territories of four attiguous communes, Pomerance, Castelnuevo di Val di Cecina, Massa Marittima, and Montieri. It is not extracted in the solid state, but, as is generally known, is brought to the surface through innumerable crevices, probably faults in the cretaceous and eocene rocks, being mechanically mixed with vapor of water at a high temperature and under great pressure, and artificially imprisoned by the condensation of the steam by means of cold water, whence it is brought into certain reservoirs of a more or less circular form, very shallow, lined with masonry consisting of fragments of limestone and coated with hydraulic lime, so as to resist, as well as possible, the corroding action of the acidulous liquid with which the stone comes in contact in these *lagoons*.

The first operation is to make bore holes in localities where the natural heat leads to the hope of finding the vapors.

Where the water penetrates into the internal fissures of the rock, a certain portion of boraciferous mineral is dissolved, the exact nature of which is not yet precisely ascertained, in spite of the splendid studies of Payen, Dumas, Bechi, Sainte-Claire-Daville, Leblanc, Fouqué, etc. Bechi considers that the boracic acid is due to the decomposition of some borate existing in the strata at great depths, by the agency of vapor. At first he suggested that it might be a nitride of boron, then a borate, probably a borate of lime. After the water of the boraciferous lagoons

* See frontispiece.

has been for some time in contact with the steam into which it is converted, it is forced out of the fissures in the rock at the boiling point by its own pressure; this operation is repeated several times without any human agency, and when sufficiently enriched, the boiling contents of the lagoon are conducted to the shallow evaporating pans, made of sheet lead, termed *Adrian evaporators*, where the boracic acid is gradually concentrated to the point of saturation, when it crystallizes by a series of manipulations as simple in their application as they are elegant. The process will be found detailed in the author's *Guida alle acque minerali dell'Italia*, Provincia Centrale, vol. I, p. 116, Torino, 1868, to which the reader is referred, as well as to the author's *Tesori Sottorrainei dell'Italia*, vol. II, pp. 427 to 432, and pp. 454 and 455, and to his *Mineral Resources of Central Italy*, published in English in 1868, and now getting rare.

Professors Fouqué and Gorceix give the composition of the gases emanating from the boracic acid lagoons, as follows:

Nature of the Gases in 100 parts.	Vapor Emanations of—		
	Lardarello.	Serrazzano.	Sasso.
Carbonic acid gas	90.47	87.90	88.33
Hydrosulphurous acid gas	4.20	6.10	5.43
Marsh gas	2.00	0.97	2.55
Nitrogen	1.90	2.93	1.55
Hydrogen	1.43	2.10	2.01
Oxygen	----------	----------	0.13

Professor Schmidt, of Dorpat, found the muddy deposit of the lagoons to contain gypsum (sulphate of lime). sulphate of ammonia, sulphate of magnesia, hyposulphate of ammonia, and small quantities of sulphate of potash and soda, besides very small proportions of carbonate of ammonia and sulphide of ammonium, together with fragments of undecomposed rock, the whole colored by sulphide of iron.

Professor Monoghini, in his beautiful monograph on boracic acid, observes that the lagoons of Serrazzino are in the immediate proximity of serpentinous rocks, which he considers, in common with the greater part of geologists, as *eruptive*. He considers that the subterranean emanations come to the surface at the line of contact of the serpentine rocks and the molasse and shelly limestone, belonging, both of them, to the Miocene period. For my own part, I have absolutely renounced my former belief in the eruptive nature of serpentine and allied rocks, so leaving the explanation of this point to more able minds than my own. This being certainly no easy problem to solve, I will only say that as I hold the more recent views of Gastaldi, Gerlach, Sterry Hunt, and other geologists, I conceive there must exist here a center of immense activity of chemical decomposition, the center of which is probably connected with the serpentine rocks of prepaleozoic age, in the presence of water. The importance of these phenomena is such as to be surpassed alone in their whole, by volcanic phenomena alone, and therefore it is not to be wondered at they have always excited the interest of the greatest of men of science, though they afford a further ample field for useful research to future investigators. The boracic acid itself, whatever be the state in which it exists in the rock, seems to be contained in some soluble combination in the Tertiary, or at most in the Cretaceous sedimentary rocks.

I have the firm conviction that *volcanic phenomena of all kinds, as well as earthquakes of volcanic origin, are absolutely extraneous to the boracic acid lagoons of Central Italy*, never having heard of a single plausible argument in their favor, after a more accurate examination of the neighborhood than I could make the first time I visited it, and as given in my *Mineral Resources of Central Italy*.

This does not, however, exclude the probability of faults according to certain directions as first suggested by Murchison, to have been due to very ancient earthquakes, and affording the means for the passage of boracic acid and vapor of water. (†)

Laying aside the volcanic origin of the boracic acid lagoons, of which I wrote in my *Mineral Resources of Central Italy*, and which I wrote in deference to the celebrated chemists and geologists who had preceded me, but which I now consider to be far from correct, the reader will find in the little volume mentioned a very detailed technological and historical account of the boracic acid lagoons of Italy, as well as statements of the annual production up to 1859. Since that time it has been absolutely impossible for any one to get statistical statements of the quantity of boracic acid produced, but I believe it may be taken as being about equal to what it used to be. The discovery of boracic acid in the United States for some time produced a considerable perturbation in the trade of Italian boracic acid, it is true, but the clear profits are so fabulously great, and the expenses so insignificant, that should the prices fall 60 or 70 per cent from what they used to be, in all probability that circumstance would have as its only consequence to diminish the profits but not to prevent the production from proceeding exactly as before.

(†) JERVIS *I. Tesori Sotterranei dell' Italia*, *Torino*, 1874, Vol. 2, pp. 454, and following, which see.

At the lago di Monte Rotondo, in the commune of Massa Marittima, Province of Grossetto, many celebrated geologists may have taken this natural depression for the crater of an extinct volcano; its *form*, indeed, would authorize such a possible conjecture, but nothing more, for the rocks around are entirely sedimentary, and either Cretaceous or Tertiary, as at Pomarance. By means of deep borings, the rock has been brought into communication with water from the surface, and which would rather seem to be converted into vapor by such means, than to be natural steam or hot vapor of water already existing in the rock itself. The steam, charged with infinitesimal proportions of boracic acid rises to the surface of the ground through the bored holes, under very considerable pressure.

It is stated that the expense of producing a ton of boracic acid of commerce, in the crystallized state, but not refined, is as follows:

Manual expenses	$10 00
Packing and carriage	13 00
Administration	8 60
General expenses, repairs, etc.	28 40
Taxes	13 00
Total	$73 00

Boracic acid also exists in volcanic rocks. The chief place in Italy where it occurs in some quantity is in the crater of the semi-extinct volcano of Vulcano, in the island of the same name, one of the classical Æolian group, close to Lipari, in Sicily. General Nunzianti, who lately died, worked both boracic acid and sulphur, which deposit on the interior of the crater, and can be collected on a small scale. Alum works were also made at the outer base of the mountain. Little capital was spent on the undertaking, which seems to have been conducted with little skill. At all events, it was sold by the General to a manufacturer of chemical products in Glasgow, who began working it about the year 1873. The necessary reservoirs were made and something began to be done, when it would appear that the American boracic acid competed too powerfully, and the affair was left standing idle.

The following report is from the "Commercial Relations of the United States." Reports from the Consuls of the United States on the commerce, manufactures, etc., of their consular districts. No. 18. April, 1882. Published by the Department of State, according to Act of Congress.

THE PRODUCTION OF BORACIC ACID IN ITALY.

[Report by Consul Rice, of Leghorn.]

I have recently returned from a most interesting excursion in the Volterra and Pomarance districts of the province of Pisa, and spent a short time at the mineral water establishment called "Bagni a Morbo," situated in the center of the circle of springs yielding boracic acid, the property of Count de Larderel; and, while there, had ample opportunity to examine and study the same. I have considered the subject worthy of report, inasmuch as boracic acid is largely exported to the United States from Leghorn.

The nearest of the boracic acid springs to Morbo (which establishment is also the property of the de Larderel family) is called "Lardarello;" the springs in and around the village so named, and about forty in number, besides which, others exist which are not worked.

Lardarello is the most important of the seven "borax villages" (if I may so term them), which are respectively named Lardarello, Sasso, Lago di Monte Rotondo, Lusignano, and Serrazzano. The technical direction is here, as also the mansion of the Larderel family; the church, theater, schools, warehouses, stores, etc.; in fact, Lardarello is a model village, and apart from the scientific and commercial importance of the locality, is worthy of a visit simply as a specimen of what an intelligent and generous employer of labor can do, if so disposed, for the comfort of his laborers.

The properties of the springs, called on the spot "lagoni" or lagoons, were first discovered by two chemists attached to the Tuscan Grand Ducal Court, named Pietra Hœffer and Paolo Mascagni, in the year 1777; but the springs do not appear to have been effectually worked till early in the present century.

About the year 1824, Count de Larderel (grandfather of the present generation of proprietors) associated with a Frenchman named Lamotte, and commenced working, evaporating the water which rose with the acid, and crystallizing the remainder by means of wood fires, and this process continued till the sparsely wooded hills in the neighborhood were left bare of timber, and then the enterprise was nigh falling into neglect. It is said that accident alone, some thirty to thirty-five years since, decided Count de Larderel, then become sole proprietor, to utilize the hot steam issuing from the hot springs themselves to vaporize the water and crystallize the borax, and the system then introduced maintains its sway at the present time.

It would appear that the whole of this neighborhood contains most extensive borax deposits, and though nature allows the vapor to find its way through the natural fissures in the soil, it is by no means from such natural issues that the most abundant supply is obtained. Experience has shown that by the judicious use of artesian wells a far greater result is obtained.

The system followed is this: A shallow pond is dug, and in it an artesian well is bored, which at a small depth invariably strikes the vein of borax; not content with vapor alone, the boring is carried down till the well gives water; the boring machinery is then withdrawn, and water let into the pond; the upshoot of the boring heats this pond to boiling point in a few minutes, and the boiling in a very short time impregnates the water in the pond with boracic acid shot up with hot water from the artesian well; there only remains to draw off the water, which is done every twenty-four hours, and evaporate it. This process is effected by passing it over a series of shallow metal pans arranged as a cascade; the fall from one pan to another may be two to three inches, and the pans are fifteen to twenty in number.

Underneath the pans are a series of hot steam pipes, which keep the shallow pans at an intense degree of heat, the consequence being that a very large portion of the liquid which reaches the last or bottom pan is semi-solid boracic acid; this is then pumped into vats and allowed to cool, and when cold the vats have the appearance of being frozen over with a thick skin of very dirty and rotten ice; this skin is removed and strewed on the floor of a drying house heated by hot pipes under the floor, and by this means the acid becomes crystallized.

The boracic acid is then ready for packing; the color being the same in all cases, varying from a dirty white to almost black; the acid is mixed in the stores and packed in huge casks, weighing 14 to 16 cwt., for exportation.

The lagoons are most interesting to watch. When full of water the boiling is continuous, rising (especially in the case of the artesian borings) to some feet in height. When natural springs, the bubbles are about a foot above the level of the water; the vapor is, however, most clammy, and especially unpleasant from its excessive sulphurous odor.

When the water is pumped out, the bottom of the lagoon remains of a dirty mud color, with round, semi-spherical holes like pock-marks, varying from a foot to several feet in diameter and depth; these are the springs. When empty they each give off a small amount of vapor, but as water finds its way into the holes in question, ebullition commences, and each hole appears to be a cooking pot, boiling with all its might, the water rising more and more, the lagoon one huge boiling caldron.

The difficulty in the production, and a very grave difficulty it is, consists in the scarcity of water; in fact, in the Summer Lardarello is almost the only establishment that can work satisfactorily, and even at Lardarello the works are often working half time only. The water which has served in the mineral baths at Morbo is carefully drained down to the Lardarello reservoir, and there stored.

When I visited the place, after a long and particularly hot Summer, water for the works had become a precious thing. The residents, of course, get used to it, but visitors to Lardarello find any lengthy stay there unpleasant in the extreme, from the enormous quantity of moisture and vapor permanently suspended in the atmosphere, as also the oppressive smell of sulphur. The effect of this on metals may well be imagined. I happened to see in the music-room a strange looking musical wind instrument of a novel form to me, it being black and covered with a greasy coating a millimeter thick. I concluded it was an antique, and was amazed when I learned that it was a recent present from Count Lardarel to the band, and that what I saw was simply the normal state of all brass instruments there. The chemist's silver watch looked more like platinum than silver, and the chemist told me that only good gold of the purest quality kept its color.

Matters have been so arranged by the Larderel family that their work-people, save for alimentary substances and raw materials, are almost independent of the outer world. The men and boys work on the borax, and the female portion of the community spin and weave. I visited a building containing some thirty looms, and the stuffs manufactured were really very fair in quality; the workers are paid by the piece, and the whole is put into store, the entire population drawing their textile fabrics thence at moderate prices. There is a doctor, a resident chemist, priest, schoolmaster and mistress, a bandmaster, etc. In case of illness the workman is sent at Count Larderel's expense to Morbo, or other thermal establishment, as may be necessary, without losing pay. The houses are neat, airy, and commodious. The church is worthy of a larger village; in it I found a pulpit and altar, frontal in bronze, which Count de Larderel purchased at the English exhibition in 1851.

I understand that the health of the people is excellent as a rule, and I was interested in hearing one of the head workmen, speaking of their contented life, saying, "We pray to God for the Larderel family first, and for ourselves afterwards." How many employers of labor in the world have had that said of them?

My remarks have been confined to Lardarello, the other stations being but Lardarello on a smaller scale.

It would be most difficult to estimate with any degree of certainty the quality of borax produced, as all are reticent in the extreme on this point. From what I could glean, going from one source to another, I gathered that Lardarello averages three to three and a half tons per day, and that this station produces nearly one half of the whole quantity extracted, which would make some eleven tons per diem as the total production.

At Leghorn I have been unable to control these figures; the exports to other countries I have been unable to ascertain with precision. To the United States, 1,240,746 kilograms—value, $211,061 85—was exported in 1880. This would be about one third of the whole amount produced.

During the first three quarters of 1881, there was a heavy falling off, which I have noted in former reports, exports to the United States amounting only to 65,648 kilograms; value, $14,098 51.

The laborers on the Larderel property numbered one thousand eight hundred persons, of whom eight hundred males are employed in the acid production.

I may add here a few words regarding the baths of Morbo, used by the famous "Lorenzo il Magnifico," celebrated in Tuscan history; they contain springs hot and cold, comprising the properties of the mineral waters of Vichy, Montecatini, Casciana, etc. I saw myself persons suffering from chronic rheumatism *carried* into the establishment like children in arms, who, after a three or four weeks' cure, walked away with the elastic step of youth.

It is to be regretted that the present proprietor does not fit up the establishment for the reception of invalids, as its sulphur and iron springs are far superior to any in Italy, and equal to any in Europe.

WILLIAM T. RICE, Consul.

UNITED STATES CONSULATE,
LEGHORN, ITALY, March 13, 1882.

Boracic acid is found in a free state in the waters of the lake of Monte Rotondo, in Italy, which lies near the lagoons before described. The waters contain one part of crystallizable boracic acid in five hundred, which is recovered by evaporation. The area of the lake is about eighteen acres. M. Duval, by whom the lake is worked, extracted sixty-four tons in 1854 and one hundred and forty-two tons in 1855. The following is the result of two analyses of crude Italian boracic acid by Professor Luca, as published in the report on the mineral resources of Central Italy by W. P. Jervis:

	No. 1.	No. 2.
Anhydrous boracic acid	50.7	46.6
Water	36.9	40.4
Sulphuric acid	9.1	9.5
Chlorine	0.2	0.1
Silica	1.0	1.2
Magnesia	1.1	1.3
Lime	0.5	0.6
Ammonia	0.3	0.4
Potash, soda, alumina, oxide of iron, and organic matter	trace	trace
	99.8	100.1
Impurity in the above	12.2	13.1
Crystalline boracic acid in one hundred parts	89.0	84.3

PRODUCTION OF BORACIC ACID AT THE WORKS OF COUNT LARDAREL, IN TUSCANY, FROM 1818 TO 1859, INCLUSIVE. (JERVIS.)

YEARS.	No. of Years.	Tons.	Cwt.	Pounds.
1818 to 1828	10	521	16	1,168,832
1828 to 1838	10	4,870	6	10,909,472
1839	1	748	13	1,676,976
1840	1	878	13	1,968,176
1841	1	886	6	1,985,312
1841 to 1845	4	3,695	2	8,277,024
1845 to 1850	5	5,218	5	11,688,880
1851	1	1,140	00	2,553,600
1852	1	1,156	19	2,591,568
1853	1	1,208	19	2,708,048
1854	1	1,319	7	2,955,344
1855	1	1,332	19	2,985,808
1856	1	1,427	1	3,196,592
1857	1	1,711	4	3,833,088
1858	1	2,026	10	4,539,360
1859	1	1,830	18	4,101,216
Totals	41	29,972	18	67,139,296

In 1861, more than 1,800 tons.

UNITED STATES.

[Senate Misc. Doc. No. 46, 49th Congress, 1st Session.]

IMPORTS AND DUTIES—1867 TO 1878. No. 110—ACIDS: BORACIC.

Fiscal year ending June 30	Quantity—Pounds	Value	Rate of duty	Amount of duty received	Additional and discriminating duty	Average value per unit of quantity	Average duty reduced to ad valorem—Per cent
1867	770,756	$73,396 00	5 cts. per pound.	$38,537 80	----------	.095	52.51
1868	243,993	22,845 00	5 cts. per pound.	12,199 65	----------	.092	53.40
1869	998,033	109,974 00	5 cts. per pound.	49,401 65	----------	.110	44.92
1870	1,166,145	173,806 00	5 cts. per pound.	58,307 25	----------	.148	33.55
1871	1,204,049	185,477 00	5 cts. per pound.	60,202 45	----------	.154	32.46
1872	1,103,974	191,575 00	5 cts. per pound.	55,198 70	----------	.171	28.81
1873	1,222,006	255,186 00	Free of duty.	----------	----------	.208	Free.
1874	233,955	52,752 00	Free of duty.	----------	----------	.226	Free.
1875	41,742	6,280 00	Free of duty.	----------	----------	.150	Free.
1876	137,518	15,711 00	Free of duty.	----------	----------	.114	Free.
1877	107,468	11,231 00	Free of duty.	----------	----------	.105	Free.
1878	178,798	14,925 00	Free of duty.	----------	----------	.085	Free.

Boracic acid was placed on the free list June 6, 1872, and has been exempt from duties until recently. The duties at present, by late Acts of Congress, are as follows:

Refined borax	5 cents
Pure boracic acid	5 cents
Commercial borax	4 cents
Borate of lime	3 cents
Crude borax	3 cents

IMPORTS AND DUTIES—BORAX AND BORACIC ACID.

[Reports of U. S. Custom House.]

IMPORTS AND DUTIES—1867 TO 1878.—No. 168.—BORAX, CRUDE OR TINCAL.

Fiscal year ending June 30	Quantity—Pounds	Value	Rate of duty	Amount of duty received	Additional and discriminating duty	Average value per unit of quantity	Average duty reduced to ad valorem—Per cent
1867	5,672	$711 00	5 cts. per pound	$283 60	----------	.126	40.00
1868	22,293	2,985 00	5 cts. per pound	1,114 65	----------	.132	37.50
1869	54,822	8,011 33	5 cts. per pound	2,741 10	----------	.150	34.25
1870	2,616	322 00	5 cts. per pound	130 80	----------	.125	40.62
1871	5	1 00	5 cts. per pound	25	----------	.200	25.00
1872	----------	----------	----------	----------	----------	----------	----------
1873	----------	----------	----------	----------	----------	----------	----------
1874	588	78 00	Free of duty.	----------	----------	.132	Free.
1875	----------	----------	----------	----------	----------	----------	----------
1876	----------	----------	----------	----------	----------	----------	----------
1877	55	12 00	----------	----------	----------	.219	----------
1878	286	61 00	----------	----------	----------	.213	----------

No. 169.—Borax, Refined.

Fiscal year ending June 30	Quantity—Pounds	Value	Rate of duty	Amount of duty received	Additional and discriminating duty	Average value per unit of quantity	Average duty reduced to ad valorem—Per cent
1867	49,652	$6,601 50	10 cts. per pound	$4,965 20		.132	75.21
1868	79,183	10,127 00	10 cts. per pound	7,918 30		.127	78.1
1869	89,695	12,799 00	10 cts. per pound	8,969 50		.142	70.0
1870	97,078	14,511 28	10 cts. per pound	9,707 80		.151	66.9
1871	134,927	20,705 24	10 cts. per pound	13,492 70		.153	65.1
1872	35,542	6,288 00	10 cts. per pound	3,554 20		.176	56.52
1873	9,284	2,152 00	10 cts. per pound	928 40	$22 40	.231	43.14
1874	3,860	1,253 00	10 cts. per pound	386 00		.324	30.80
1875	5,153	1,224 15	10 cts. per pound	515 30		.237	42.09
1876	3,145	691 35	10 cts. per pound	314 50		.220	45.49
1877	3,500	676 10	10 cts. per pound	350 00		.193	51.77
1878	3,492	514 00	10 cts. per pound	349 20		.147	67.93

No. 275.—Lime, Borate of.

Fiscal year ending June 30	Quantity—Pounds	Value	Rate of duty	Amount of duty received	Additional and discriminating duty	Average value per unit of quantity	Average duty reduced to ad valorem—Per cent
1867							
1868							
1869							
1870	33,529	$1,666 00	5 cts. per pound	$1,676 45	$64 30	.049	100.63
1871	45,600	2,248 00	5 cts. per pound	2,280 00		.047	101.50
1872	22,500	800 00	5 cts. per pound	1,125 00		.035	140.62
1873							
1874							
1875							
1876							
1877							
1878							

No. 26.—Imported Merchandise entered for Consumption, etc., during the Year ending June 30, 1881.

Articles.	Withdrawals from Warehouse, and entries for immediate consumption.	Quantities. (Pounds.)	Values.	Discriminating duty.
Free of duty.				
Boracic acid	Immediate	187,053	$15,771 00	

No. 26.—Imported Merchandise Entered for Consumption, Etc., during the Year ending June 30, 1881.

Articles.	Withdrawals from Warehouse, and entries for Immediate Consumption.	Quantities. (Pounds.)	Values.	Rates of Duty.	Duty.			Average value per unit of quantity	Average ad valorem rate of duty—per cent.
					Ordinary.	Additional and discriminating.	Total.		
Dutiable.									
Borax, refined	Immediate	4,136	$865 50	10 cts. per pound	$413 60	----------	$413 60	$0.209	47.79

No. 30.—Imported Merchandise Entered for Consumption, Etc., during the Fiscal Years ending June 30, 1879, 1880, and 1881.

Articles.	Year ending June 30, 1879.			Year ending June 30, 1880.			Year ending June 30, 1881.		
	Quantities. (Pounds.)	Values.	Discriminating duty.	Quantities. (Pounds.)	Values.	Discriminating duty.	Quantities. (Pounds.)	Values.	Discriminating duty.
Free of Duty.									
Boracic acid	306,462	$21,888 00	----------	243,733	$18,473 00	----------	187,053	$15,771 00	----------
Borate of lime	----------	----------	----------	22,122	742 00	----------	----------	----------	----------

No. 30.—Imported Merchandise Entered for Consumption, Etc., during the Fiscal Years ending June 30, 1879, 1880, and 1881.

Articles.	Rates of Duty.	Year ending June 30, 1879.			Year ending June 30, 1880.			Year ending June 30, 1881.		
		Quantities. (Pounds.)	Values.	Duties.	Quantities. (Pounds.)	Values.	Duties.	Quantities. (Pounds.)	Values.	Duties.
Dutiable.										
Borax, refined	10 cts. per pound	3,472	$490 00	$347 20	15,278	$2,011 00	$1,527 80	4,136	$865 50	$413 60

YEAR ENDING JUNE 30, 1880.

Boracic Acid—Free.		Borax, refined—10 Cents per Pound.	
Quantity—(Pounds).	Value.	Quantity—(Pounds).	Value.
63,756	$4,368 00	9,489	$884 00
23,015	1,741 00	1,232	213 00
106,123	7,806 00	4,367	866 00
48,557	4,294 00		
241,451	$18,209 00	15,088	$1,963 00

YEAR ENDING JUNE 30, 1881.

Boracic Acid—Free.		Borax, refined—10 Cents per Pound.	
Quantity—(Pounds).	Value.	Quantity—(Pounds).	Value.
93,077	$6,207 00	1,568	$351 00
22,900	1,832 00	1,224	275 00
69,029	7,375 00	560	127 00
185,006	$15,414 00	3,352	$753 00

FISCAL YEAR ENDING JUNE 30, 1882.

Boracic Acid—Free.		Borax, refined—10 Cents per Pound.	
Quantity—(Pounds).	Value.	Quantity—(Pounds).	Value.
68,644	$9,647 00	3,450	$848 00
190,902	20,821 00	1,796	374 00
141,811	22,211 00	3,514	1,363 00
128,146	17,400 00	1,904	477 00
529,503	$70,079 00	10,664	$3,062 00

The following tables show the various duties imposed by our laws since 1842:

	1842.	1846.	1857.	1861.	1867 to 1872.	1873 to 1883.
Boracic acid	5 per ct.	20 per ct.	4 per ct.	10 per ct.	5 cts. per lb.	Free.

	1842.	1846.	1857.	1861.	1867 to 1883.
Refined borax	Free.	25 per ct.	30 per ct.	3 cts. per lb.	10 cts. per lb.

	1842	1846.	1857.	1861 to 1867.	1867 to 1883.
Borate of lime	25 per ct.	20 per ct.	12 per ct.	10 cts. per lb.	Free.

	1842.	1846.	1857.	1861.	1867 to 1873.	1875 to 1883.
Tincal (crude)	25 per ct.	25 per ct.	4 per ct.	Free.	5 cts. per lb.	Free.

CONSUMPTION, IMPORTATION, AND PRODUCTION OF BORAX AND BORACIC ACID.

It is impossible to estimate the cost of production of borax in California and Nevada, for the reason that the producers decline to give the information, but it may be assumed that with few exceptions it has not proved a remunerative business, for the reasons stated elsewhere.

Before March, 1873, the Legislature of Nevada passed a law taxing the proceeds of borax and soda mines.

For the quarter ending March, 1873, three companies reported, as follows:

A. M. Hearn:

Gross proceeds	$12,318 00
Total expenses	8,785 00
Net profits	$3,533 00

Or about $154 per ton.

Mosheimer & Engelke:
Net profits on ten tons, $210, or $21 per ton.

Pacific Borax Company:
Net profits on 113 tons, $1,737; about $15 per ton.

In 1866 the consumption of borax in Great Britain was estimated by Ross Brown at 11,000 tons. Seventy-five tons of borax are consumed on the Pacific Coast.

Charles Pfeiser, of New York, estimates the consumption of boracic acid in the United States as follows, all of which is imported:

Manufacture of borax	2,000,000 pounds
Preserving meat	300,000 pounds
Manufacture of glass and pottery	300,000 pounds
Total	2,600,000 pounds

In 1882 the total consumption of borax in the United States was estimated at 1,600,000 pounds.

The Oil, Paint, and Drug Reporter of January 18, 1882, estimates the importation of boracic acid into New York for the year 1881 at 1,659,256 pounds.

The importations of boracic acid into New York for the ten months ending November 1, 1882, was 2,009,993 pounds.

The following examples of the imports of boracic acid into England are from Ure's dictionary—values calculated into dollars:

For the Year 1855.

	Amount in pounds.	Value.
Sardinia	9,520	$1,857 55
Tuscany	2,999,024	587,640 55
Gibraltar	106,064	20,782 25
Total	3,114,608	$610,280 35

For the Year 1856.

	Amount in pounds.	Value.
Sardinia	35,056	$6,678 45
Tuscany	2,807,056	534,780 40
Peru	1,453	31,010 90
Other parts	112	19 40
Total	2,843,677	$572,489 15

The following tables, showing the production of borax in the Pacific States, have been prepared with great care, and are as nearly correct as possible. The figures have been furnished by the producers themselves, or by those who have bought and sold their products:

PRODUCTION OF BORAX OF THE PACIFIC STATES—IN POUNDS.

Year.	California.		Nevada.		Total.
	San Bernardino Borax Man'fng Co.	Others.	Smith Bros.' Pacific Borax Co.	Others.	
1864		24,304			24,304
1865		251,092			251,092
1866		401,632			401,632
1867		439,824			439,824
1868		64,513			64,513
1869					
1870					
1871					
1872		280,000			280,000
1873	750,000	280,000		970,000	2,000,000
1874	1,729,891	99,980	2,003,930	166,199	4,000,000
1875	2,147,000	189,000	2,315,260	488,740	5,140,000
1876	2,752,000	121,909	1,740,720	566,281	5,180,910
1877	1,986,970		2,735,700	4,610	4,727,280
1878	746,840		2,055,960		2,802,800
1879	727,146		827,840		1,554,986
1880	1,219,948		2,640,800		3,860,748
1881	1,380,205		2,665,200		4,045,405
1882	1,465,732		2,350,539	420,020	4,236,291
1883	720,000	80,000	1,567,724	432,276	2,800,000
Totals*	15,625,732	2,232,254	20,903,673	3,048,126	41,809,785

*To June 1, 1883.

PRINCIPAL PRODUCERS OF BORAX ON THE PACIFIC COAST.

California.	Amount, (lbs).	Total, (lbs).
California Borax Company	1,741,364	
San Bernardino Borax Mining Company	15,625,732	
Dodge & Co.	254,209	
Others	236,681	
		17,857,986
Nevada.		
Smith Bros.	18,007,511	
Pacific Borax Company	2,896,162	
Jos. Mosheimer	553,240	
Smith & Storey	501,910	
Teel's Marsh Borax Company	344,760	
English & Shaver	250,320	
Judson & Shepard	216,360	
J. M. Kane	66,120	
American Borax Company	46,900	
Johnson & Shaver	132,120	
A. J. Rhodes	29,280	
D. H. Dillard	21,120	
L. A. Engelke	18,980	
E. Griswold	7,000	
R. M. Johnson	6,720	
S. Austin	1,000	
Nevada Salt and Borax Company	82,300	
W. J. Houston	43,400	
Others	726,596	
		23,951,799
Grand total to June 1, 1883		41,809,785

SALES OF BORAX BY THE CALIFORNIA BORAX COMPANY.

1864	24,304 lbs.	Shipped to New York
1865	250,880 lbs.	Shipped to New York
1865	212 lbs.	Sold in San Francisco
1866	353,248 lbs.	Shipped to New York
1866	48,384 lbs.	Sold in San Francisco
1867	374,752 lbs.	Shipped to New York
1867	65,072 lbs.	Sold in San Francisco
1868	64,512 lbs.	Sold in San Francisco
Total	1,181,364 lbs.	

RECAPITULATION.

Sold in New York	1,003,184 lbs
Sold in San Francisco	178,180 lbs
Total	1,181,364 lbs

NEW YORK JOBBERS' PRICES OF BORAX, FROM 1864, TO MAY, 1883.

Showing the fluctuations caused by the production of California and Nevada Borax, in cents per pound.

	1864.		1865.		1866.		1867.		1868.		1869.	1870.		1871.		1872.		1873.	
Highest price	Oct.	50	Feb.	44	Dec.	35	Nov.	37	Sept.	38	40	Mar.	35	July	37	May	38	Feb.	38
Lowest price	Mar.	28	Sept.	31	July	31	Mar.	34	July	34	40	Jan.	34	Jan.	32	Jan.	33	Sept.	25

	1874.		1875.		1876.		1877.		1878.		1879.	1880.		1881.	1882.		1883.	
Highest price	Feb.	24	Nov.	17	Mar.	16	June	14	Jan.	12	11	Mar. to Dec.	12	15	May to Oct.	17	Apr.	16
Lowest price	Dec.	14	Jan.	16	Nov.	12	Dec.	10	July	7¼	11	Jan.	10	15	Jan.	14	Jan.	14

NEW YORK JOBBERS' PRICES OF BORACIC ACID, FROM 1867, TO MAY, 1883.

*Showing the fluctuations caused by the production of California and Nevada Borax, in cents per pound.**

	1868.		1869.	1870.	1871.	1872.	1873.		1874.		1875.	1876.
Highest price	July	85	85	85	85	85	Feb.	85	Mar. to Dec.	80	77	77
Lowest price	June	80	85	85	85	85	Apr.	65	Feb.	70	77	77

	1877.		1878		1879.		1880.	1881.	1882.	1883.
Highest price	Jan.	77	Jan. to Dec.	55	Jan.	45	37	37	37	37
Lowest price	Dec.	62	Dec.	45	Feb. to Dec.	37	37	37	37	37

* The information used in the construction of this and the borax table was compiled from files of the Druggists' Circular, by Mr. James G. Steele, of San Francisco.

BORAX MINERALS AND THOSE CONTAINING BORACIC ACID IN SMALL QUANTITIES.

BORAX.

Biborate of soda, native borax, or *tincal*, has been described in the body of this work. The chemical and mineralogical characteristics are given below:

It has a sweetish taste and an alkaline reaction. It dissolves in twelve parts of cold water and in two parts of boiling water. At a low heat it melts in its water of its crystallization; if the heat be continued, it swells and becomes a white porous mass. At a red heat it fuses into a transparent fluid, which becomes, when cold, a transparent solid resembling glass. Fused with fluorspar and bisulphate of potash it colors the blowpipe flame distinctly green. Luster, vitreous; color, white, gray, brown, pinkish, greenish; generally translucent, sometimes transparent; brittle, streak white; phosphorescent if powdered in the dark.

The most beautiful transparent and perfect crystals form at the borax works in weak solutions, which have been allowed to stand for a considerable time undisturbed. The purest natural crystals are found on the property of the San Bernardino Borax Company, which are shoveled into the tanks by the ton. They differ from the celebrated crystals from Borax Lake, Lake County, in being transparent and inclosing fluid in large cavities.

SASSOLITE.

Native boracic acid has been sufficiently described in the body of the work under the head of boracic acid.

ULEXITE.

Borate of Lime, Tiza, Boronatrocalcite, Natroborocalcite, Tinkatzit, Cotton Balls, Sheet Cotton, etc.

Ulexite is a natural hydrated borate of lime and soda. This curious mineral was first found in the nitre beds of Peru in small quantities, in small globular concretions, showing when broken interlaced, silky-white crystals; sometimes also inclosed crystals of salt or gypsum. It was first examined by Ulex. His analysis of a specimen from Iquique, Southern Peru, gave:

Boracic acid	49.5
Lime	15.9
Soda	8.8
Water	25.8
Total	100.0

The mineral was afterwards analyzed by A. A. Hayes, who proposed the formula ($CaO, 2\ BO_3+6HO$). He supposed the soda found by Ulex to result from mechanically mixed glauberite. For some time this mineral was called "Hayesene;" but Dana, in the last edition of his work on mineralogy, gives it the name of Ulexite, in justice to the first observer.

The following extracts from "Mineraux du Pérou," by A. Raimondi, Paris, 1878, seem to show the analysis of Hayes to have been a mistake.

Ulexite was first found in the Province of Tarapaca, then named Borax or Tiza—lately found in the Cordillere de Maricunga, at an altitude of 3,800 meters (12,464 feet). Mr. Raimondi calls attention to a widespread error found in works on mineralogy, as to a borate of lime without soda, under the name of Hayesene, which, in his opinion, does not exist in Peru. In 1853, while in the employ of the Government of Peru, he visited all the known localities of the borates in the Province of Tarapaca. He examined a large number of specimens, and made a great number of excavations, and his conclusions were that the sample of borate of lime called Hayesene was Ulexite, or Boronatrocalcite. Ulexite was found for the first time in 1836–7, in Tarapaca, forty or fifty kilometers from Iquique, under the crust that covers the nitrate of soda beds, nearly always in little rounded masses from the size of a hazelnut up to that of a potato—color white, fibrous, and silky. Very often the balls of ulexite have in their interior a nucleus of glauberite. The first notice in the Scientific Press is found in the second edition of the mineralogy of Dana, 1844, page 243, in which the author says that he had received a communication from Mr. Hayes, descriptive of a new mineral, under the name of borate of lime (*borocalcius obliquus*). But in that description Mr. Hayes confounded borate of lime with glauber salt in a state of mixture:

I repeat here what I have already said, that I possess the most intimate conviction that the mineral described by Mr. Hayes as presenting rounded masses showing fibrous, white, silky crystals frequently accompanied by glauberite, is borate of lime and soda, and not simple borate of lime.

The many analyses which I made of all the specimens collected while Commissioner to the Government of Peru in 1853; the analysis made in 1855 by the distinguished chemist Rammelsberg, of the material which presented all the physical characters of the doubtful Hayesene, establishes in a manner nearly certain that in Peru there exists only a single combination of boric acid with lime, and that the combination is a double borate of lime and soda, described in works on mineralogy, under the name of ulexite or boronatrocalcite.

To complete what I have said on this important mineral, I give the composition of three specimens of boronatrocalcite found in a state of great purity in a very dry earth in the province of Tarapaca, which appear in the report which I presented to the Peruvian Government in 1854.

These results agree with those obtained by Rammelsberg, only the specimens analyzed by the latter were not pure, because the boronatrocalcite was mixed with a small quantity of chloride of sodium and sulphate of soda and lime.

ANALYSIS OF ULEXITE, OR BORONATROCALCITE.

Substance Found.	By A. Raimondi.			By Rammelsberg.
	(1)	(2)	(3)	
Boracic acid	42.98	43.13	43.04	42.12
Lime	13.94	14.14	14.06	12.46
Soda	6.96	6.92	7.05	6.52
Water	36.80	35.75	35.85	34.40
Chloride of potassium	----	----	----	1.26
Chloride of sodium	0.16	Traces.	Traces.	1.66
Sulphate of soda	0.12	Traces.	Traces.	0.81
Sulphate of lime	----	----	----	0.77
Total	100.96	99.94	100.00	100.00

Notwithstanding the fact that Mr. Raimondi failed to find hayesene there seems to be such a mineral, *a hydrous borate of lime, without soda.* Mr. N. H. Darton (American Journal of Science, 1882,) describes a mineral from Bergen Hill, New Jersey, to which he gives the name of Hayesene, which had the following composition:

Lime	18.39
Boracic acid	46.10
Water	35.46
Total	99.95

Soda, silica, and magnesia, traces.

Ulexite is found at a number of localities on the Pacific Coast, some of which have been noticed elsewhere in this paper. It occurs in rounded concretions, from the size of peas to masses ten or twelve inches in diameter. Unless the so called cotton balls are carefully selected by hand the percentage is greatly reduced by the admixture of sand, worthless soluble salts and water. Much disappointment has been experienced from this cause. Shipments have rarely failed to be much lower grade than was expected.

As early as 1871, in the examination of ulexite and impure borates from the then newly discovered Columbus marsh borax fields, I accidentally discovered that very impure borate of lime in the cotton ball form could be concentrated and purified by very simple mechanical means, which information was given to the public in a report to the Nevada Consolidated Borax Company, November 11, 1871, in the following words:

Crude borate of lime can be easily and cheaply concentrated by simple mechanical treatment with cold water, in which it is nearly insoluble. A large vat should be constructed, in which the crude material is to be placed with a quantity of cold water. The contents of the vat must be kept in slow agitation by the proper machinery, until the borate of lime has been reduced to a pulpy form, and all mechanical impurity has settled to the bottom. When these conditions are fulfilled, a plug is withdrawn, and the contents of the tub allowed to run into a settling vat. Care must be taken not to allow the sand and other impurity to flow out with the purified borate of lime. In the settler the borate of lime will soon fall to the bottom, and the clear portion, which contains biborate of soda (if that salt was associated with the borate of lime), may be recovered by proper crystallization.

The purified ulexite may then be thrown on an inclined platform and allowed to drain, and then be dried in the sun.

The borate of lime so purified should have nearly the composition of the best natural product.

As borate of lime is quite voluminous in this condition, it should be compressed by powerful screws into a smaller bulk, as crude cotton is treated for the same reason. Ulexite containing twenty-four per cent of boracic acid has a market value in London of £18 per ton of 2,240 pounds.

There is a variety of ulexite called *sheet cotton* by the prospectors, which is sometimes quite overlooked. It is granular in appearance, but under the microscope it is seen to be ulexite in minute silky crystals. There is a specimen in the State Museum (No. 3590) which shows both varieties. Ten tons of boracic acid was made from this substance at the Phœnix Chemical Works at Columbus, Esmeralda County, Nevada, of which Mr. H. S. Durden was Superintendent. A sample of this acid (No. 3591) may also be seen in the State Museum. The following mechanical analyses of crude ulexite show the nature of the impurities:

No. 1.

Sand	9.25
Water hygroscopic	21.00
Soluble salts, mostly sulphate of soda and salt	17.36
Borate of lime	52.39
	100.00

No. 2.

Sand	trace.
Water	36.80
Soluble salts	11.04
Borate of lime	52.16
	100.00

CRYPTOMORPHITE.

Cryptomorphite is a very rare mineral, found with glauber salt, only in Nova Scotia, at one locality. It is white, without luster, soft, in kernels the size of a pea. When a small portion is placed under the microscope and magnified 100 diameters, the mineral is seen to consist of rhombic plates, from which the name is derived, meaning hidden form.

ANALYSIS BY HOWE.

Boracic acid	58.5
Lime	15.6
Soda	5.8
Water	20.1
	100.0

PRICEITE.

In October, 1871, Lieutenant A. W. Chase brought to the Academy of Sciences of San Francisco a sample of chalky substance which he thought to be magnesia. A small sample was given to me for examination, which I turned over to a pupil, Mr. E. J. Shipman, who spent some time over it and reported it to be borate of lime. Never having seen borate of lime in this form, I requested him to repeat his experiments, which he did, and with the same result. I then made an examination of the mineral myself, both chemical and microscopical, which led me to class it with *cryptomorphite.* The appearance under the microscope was so characteristic that I had no doubt as to its identity. At the evening meeting, November sixth, Lieutenant Chase presented it to the Academy of Sciences. Subsequently two samples were analyzed by Thomas Price, of San Francisco, which gave the following result:

	1.	2.
Boracic acid	47.04	45.20
Lime	29.96	29.80
Water	22 75	25.00
Alkalies	.25	traces.
	100.00	100.00

In 1873, Professor Silliman made a study of this mineral, and obtained the following mean of three analyses:

Boracic acid	49.00
Lime	31.83
Water	18.29
Alumina, salt, and oxide of iron	.96
	100.08

The absence of soda separates this mineral from ulexite and cryptomorphite, and seems to make it a new species, named as above by Professor Silliman. After studying this mineral and examining many specimens, I am led to believe that it is changed from ulexite by the abstraction of the soda and part of the water. I have a specimen of colemanite which has undoubtedly changed from a ulexite cotton ball.

PANDERMITE

Is a variety of priceite. The following extracts from The London Journal of the Society of Arts, August 6, 1880, by C. C. Warnford Lock, affords all that is known relating to this mineral:

I have now to deal with a new commercial borate, which, on the score of geographical position, abundance, cheapness of working, and easy manipulation, is certainly destined in a great measure to rule the markets of Europe, and particularly of Great Britain.

The new field lies on the Tchinar-Sau, a small stream feeding the Rhyndacus River, whose outlet is in the Sea of Marmora, near the port of Panderma, on the Asiatic shore. It embraces the villages of Sultan-Tchair, Yildiz, and Omerli, and the guard-house of the Demircapon pass. The area of the field is computed at over 13,000 acres (20 square miles). Its eastern confines nearly abut upon the Rhyndacus, which has been navigated by steamers up to a point called Balakeser. A company has been formed for deepening and improving the stream, and a railway has been projected from Panderma to Balakeser. The wagon road has hitherto been utilized for transporting the mineral, the distance from Panderma to the western edge of the field being about forty English miles. The port of Panderma is regularly frequented by local steamers, and offers every convenience for shipping.

The field is situated in a basin of tertiary age, surrounded by volcanic rocks, which vary from granite on the east to trachyte on the north, and columnar basalt on the west. Several basaltic hills and dikes protrude in different portions of the basin, and the presence of hot and mineral springs further testifies to the volcanic influences which have been at work, and in which, doubtless, originated the boracic mineral. The latter occurs in a stratum at the bottom of an enormous bed of gypsum, its greater specific gravity probably impelling it downwards while the whole mass was yet in a soft state. Several feet of clay cover the gypsum bed, which is here 60 to 70 feet thick, though in places it attains to double that thickness.

The boraciferous stratum varies in depth; it has been proved for a vertical distance of forty-five feet. The mineral exists in closely-packed nodules, of very irregular size and shape, and of all weights up to a ton. Von Rath has named it "Pandermite," from the port of shipment.

In outward appearance it closely resembles a snow-white, fine-grained marble. Chemically speaking, it is a hydrous borate of lime, its composition being expressed by the formula $2CaO, 3B_2O_3, 3H_2O$; in other words, it consists of boracic acid 55.85 per cent; lime, 29.78 per cent, and water 14.36 per cent. Its richness in boracic acid is at once apparent, and places it high above the other commercial borates. Thus ordinary borax (borate of soda) contains only 36.58 per cent of the acid; boro-calcite and boronatro-calcite (borates of lime and of lime and soda) vary from 8½ per cent up to 46 per cent, and average about 40 per cent, boracite and stassfurtite (borates of magnesia), containing respectively about 63 per cent and 60¾ per cent, alone surpass it in this respect, and they can hardly be deemed commercial minerals. After very simple preparation pandermite can be very directly applied as a flux, and is more economical than borax for this purpose, thanks to its larger proportion of boracic acid.

An outcrop of the mineral was discovered by a foreigner some years since, and the bed was secretly worked; small shipments were occasionally made to Europe under the denomination of plaster of Paris, thus keeping the matter hidden, and at the same time avoiding the payment of dues and duties. The Ottoman Government has since been apprised of these irregularities and has taken energetic measures to correct them. More recently it has granted a comprehensive concession to a party of British residents, who are setting to work to develop the property. The district enjoys the great advantage of being under British protection.

The workings were at first placed under that section of the Règlement des Mines relating to quarries, but have since been transferred to the section regulating mines proper. Steps are being taken to open up the deposit in a systematic manner, by first sinking a number of bore-holes—as has been done with the Kainit beds at Stassfurt—to ascertain the points of greatest development in the basin. The locality possesses a healthy climate, except in the Autumn, when there is some ague.

Labor is very cheap and abundant, Turks, Armenians, Greeks, Circassians, Tartars, and Italians being obtainable from the neighboring villages. There is a supply of water; oak and fir timber may be procured at six to seven miles distant, and scrub for fuel covers the surrounding hills.

The actual cost of the mineral, as now worked, is as follows:

Raising and dressing (exclusive of cost of tools)	10.0 paras per oke
Transport to Panderma	9.0 paras per oke
Customs duty, 1 per cent ad valorem	.5 paras per oke
Management and other charges	2.5 paras per oke
Total	22.0 paras per oke

	£	s.	d.	
At 795½ okes per ton, and 128¼ piastres per £ sterling (1 piastre=40 paras) this will equal	3	8	3	per ton
To this must be added government royalty, 5 per cent ad valorem, say	0	5	0	per ton
Contingencies	0	10	0	per ton
Freight and insurance	0	15	0	per ton
Making a total cost, "c., f., and i."	£4	18	3	per ton

The present values of the boracic products now in the market vary from £46 to £60 per ton, according to quality; the lowest figure ever reached here has been about £20 a ton, at which price the demand would immensely increase.

Pisani, of Paris, analyzed this mineral and obtained the following result:

Boracic acid	50.1
Lime	32.0
Water	17.9
	100.0

It will be found stated elsewhere that the variety pandermite has recently been found in apparent abundance in Death Valley, Inyo County, and at Calico, San Bernardino County, and the cryptomorphic variety at the latter locality.

COLEMANITE

Is also a variety of priceite found recently in Death Valley. The following analysis was made by Thomas Price, of San Francisco, March, 1883, by whom the original priceite was first analyzed:

Anhydrous boracic acid	48.12
Lime	28.43
Water	22.20
Alumina and oxide of iron	.60
Silica	.65
	100.00

In the analysis of colemanite, the alumina, iron, and silica are probably mechanical impurities—1.25 being added proportionately to the other constituents, gives the following percentage:

Boracic acid	48.72
Lime	28.79
Water	22.49
	100.00

This gives the approximate formula $4Bo_3$, 3CaO, 6HO, which is the same obtained by Silliman for priceite, which no doubt it is in a crystalline state. As this mineral possesses certain physical properties differing from priceite, the name colemanite has been given to it to distinguish it from the soft chalky mineral found both in southern Oregon and San Bernardino County, California.

The name *colemanite* was given by the discoverer of the mineral in honor of William T. Coleman, of San Francisco, who has been identified with the borax interests of the Pacific Coast from the commencement.

PROPERTIES OF COLEMANITE.

Color and streak white; milky to transparent; hardness 3.5—4; specific gravity, 2.39; before the blowpipe exfoliates, decrepitates violently, and melts imperfectly; after considerable heating it imparts a reddish yellow color to the flame, which changes to green. The mineral pulverizes easily, fragments obscurely rhombic. It is wholly soluble in hydrochloric acid with heat. From the solution boracic acid crystallizes on cooling. The filtrate gives a white precipitate with ammonia and oxalate of ammonia. With sulphuric acid, or with fluorspar and bisulphate of potash, tinges the blowpipe flame green. Luster of the mineral vitreous to adamantine. It shows no perfect crystals, but appears like semi-crystalline calcite.

BECHILITE

Is a borate of lime without soda, and therefore resembling priceite, found by Bechi, from whom it was named, as an incrustation, at the baths of the lagoons of Tuscany.

The following analysis is by Bechi:

Boracic acid	52.2
Lime	20.9
Water	26.9
	100.0

Very little is known about this mineral, which was found only in small quantities. It has physical properties resembling ulexite and priceite.

HOWLITE,

A silicious borate of lime, is found in small imbedded globules in gypsum at Brookville, Nova Scotia.

Analysis by How:

Silica	15.25
Boracic acid	44.22
Lime	28.69
Water	11.84
	100.00

This mineral is too rare to have any commercial value.

TABLE SHOWING THE SIMILARITY OF THE BORATE OF LIME MINERALS.

	Ulexite.	Cryptomorphite.	Priceite.	Pandermite.	Colemanite.	Bechilite.	Howlite.
Boracic acid	43.04	58.50	49.00	55.85	48.72	52.20	44.22
Lime	14.06	15.60	31.83	29.78	28.79	20.90	28.69
Water	35.85	20.10	18.29	14.36	22.49	26.90	11.84
Soda	7.05	5.80					
Silica							15.25
	100.00	100.00	99.12	99.99	100.00	100.00	100.00

RHODIZITE.

Rhodizite--named from a Greek word meaning resemblance to a rose, from the red color imparted to the blowpipe flame—is a very rare mineral, found only in minute crystals on red tourmaline at one locality in the Ural Mountains. These crystals are modified dodecahedrons, so small that sufficient cannot be obtained for analysis, for which reason its chemical character is uncertain. Dana considers it a lime boracite, while Gmelin describes it as a borate of lime. Before the blowpipe it fuses with difficulty to an opaque glass, tingeing the flame first green and then red.

WARWICKITE

Is a borate and titanate of magnesia, with iron, alumina, and silica. The following analysis is by J. Lawrence Smith, who made a reëxamination of it in 1853:

Boracic acid	27.80
Titanic acid ($Ti\,O_2$)	23.82
Magnesia	36.80
Sesqui-oxide of iron	7.02
Alumina	2.21
Silica	1.00
	98.65

Hardness, 3—4; specific gravity, 3.188; color, dark brown, sometimes copper red; fracture, uneven, brittle.

This is a very rare mineral, first described by Professor C. U. Shepard, and named from Warwick, New York, the first locality. It was first supposed to be a titanate of magnesia and iron. The presence of boracic acid was discovered by Smith. It is too rare to have any commercial value, but is interesting as showing that borax minerals may exist more plentifully than is generally supposed, and that it may be to their decomposition that free boracic acid and the soluble borates are due. It occurs in a granular limestone at the locality mentioned.

LAGONITE.

Named from the lagoons of Tuscany, another rare mineral, is a borate of iron, found in earthy masses of yellow ochre, and is an incrustation at the Tuscan lagoons.

ANALYSIS BY BECHI.

Boracic acid	47.95
Sesqui-oxide of iron	36.26
Water	14.02
Magnesia, lime, and loss	1.77
	100.00

LARDERELLITE.

Named from Count Larderell, is a hydrated borate of ammonia, found in the lagoons of Tuscany. It occurs in small crystalline rhomboidal plates. It is a rare mineral, never found in quantities sufficient to have any commercial value.

ANALYSIS BY BECHI.

Boracic acid	68.556
Ammonia	12.734
Water	18.325
	99.615

BORACITE.

This mineral occurs crystallized and massive; color, white, gray, yellow, and green, streak white, fracture conchiconchoidal, uneven; sub-transparent, translucent. The massive variety which is found at Stassfurt, Prussia, under the name of *stassfurtite*, is white and hard, resembling fine grained marble; vitreous luster, inclining to adamantine; hardness, 7; specific gravity, 2.83, 2.98; pyroelectric; soluble in acids. The crystals, which are isometric or tetrahedral, have the following composition ($3MgO\ 4BO_3+\frac{1}{2}$ Mg Cl):

Boracic acid	62.33
Magnesia	27.03
Chlorine	7.91
Magnesium	2.73
	100.00

The massive variety contains sometimes six per cent of water. The boracite crystals found in the kainite beds at Stassfurt are soft and form a slimy mass with water.

The massive variety gives water in a closed glass tube; fuses in the blowpipe flame easily to a white crystalline glass, coloring the flame at the same time distinctly green; with oxide of copper on charcoal, colors the flame azure blue; soluble when powdered, in dilute hydrochloric, sulphuric, and nitric acids, found at several localities in Europe, notably at Stassfurt, Prussia, associated with salt, gypsum, and anglesite. It is reported also in Turkey, as shown by the following extract from a consular report; but as borate of lime is given as a synonym, there is some doubt as to the character of the mineral mentioned. A reference to the description of pandermite will show that the locality, if not the mineral, is the same:

[August, 1881.]

MINES AND MINERALS OF TURKEY.

[Report by U. S. Consul-General HEAP, of Constantinople.]

BORACITE (BORATE OF LIME).

This is found at Moulreh, near Yeddis, on the Asiatic side of the sea of Marmora, where one mine has been in operation for six or seven years, and another has recently commenced delivery. The present annual yield is 4,000 to 5,000 tons, of which 4,000 tons are exported to France, where it is worth from $75 to $87 per ton, delivered; the freight from Kaloninie, where it is usually shipped, ranging from 30s. per ton for sailing-vessels to 21s. per steamers. The first cost of boracite is very little.

HYDROBORACITE

Is a mineral which resembles gypsum. It is represented by a single specimen in a collection of minerals in Europe.

The following analysis is by Hess, who first noticed it:

Boracic acid	49.92
Lime	13.30
Magnesia	10.43
Water	26.33
	99.98

This mineral may be distinguished from gypsum by its fusibility.

SZAIBELYTE

Is a rare borate of magnesia found in nodules in gray limestone in Werksthal, Hungary. It is named from Szajbelyi, who first noticed it. Its occurrence in limestone is interesting in connection with the theory that rock formations contain borax minerals in very large quantities.

The following analysis is by Stromeyer:

Boracic acid	36.66
Magnesia	52.49
Water	6.99
Chlorine	.49
Sesquioxide iron	1.66
Silica	.20
	98.49

TOURMALINE

Is a mineral almost invariably found crystallized, of all colors, from opaque black to nearly or quite transparent colorless. The usual colors are: *black* (schorl), *red* (rubellite), *blue* (indicolite), *green* (crysolite), *honey yellow* (peridot), *colorless* (achroite).

All the tourmalines contain boracic acid from three to ten per cent. This mineral has never been worked for boracic acid, but is probably a source of that acid in nature, resulting from the decomposition of rocks containing it. (See the description of Tuscan lagoons under head of *Boracic Acid.*) The following analysis, selected from many, is given as an example of the general composition of tourmaline:

Silica	36.71
Boracic acid	6.49
Alumina	36.00
Binoxide of manganese	6.14
Sesquioxide iron	7.14
Magnesia	2.30
Lime	.80
Soda	2.04
Potash	.38
Fluorine	2.00
	100.00

DATOLITE

Is a silicate of lime, containing from eighteen to twenty-two per cent of boracic acid. It is found in trappean rocks—gneiss, diorite, and serpentine. It has been mentioned elsewhere as a probable source of boracic acid resulting from the decomposition of rocks.

DANBURITE

Is a rare mineral, as far as known; containing twenty-seven per cent of boracic acid. It is found at Danbury, Conn., in dolomite.

AXINITE,

Another rare mineral, contains from two to six per cent of boracic acid.

SUSSEXITE

Is a newly discovered hydrated borate of manganese and magnesia, found with franklinite and other minerals in Sussex County, New Jersey. The following analysis is by Brush:

Boracic acid	31.89
Oxide of manganese	40.10
Magnesia	17.03
Water	9.59
	98.61

CHEMISTRY.

For forty-eight years after the discovery by Baron, the base of boracic acid remained unknown. Crell nearly found it in 1800, when he published a statement that boracic acid was the oxide of a substance resembling carbon. Davy repeated the experiments of Crell, but without obtaining the same results. In 1807 he submitted boracic acid to the action of a powerful galvanic battery, and obtained a black substance at the negative pole. But to Gay, Lussac, and Thenard belong the honor of first isolating the element boron, which is now known to be the base of boracic acid. The decomposition was made by fusing potassium with boracic acid in a copper tube.

Modern chemists have added much to our knowledge of boron and its compounds. Until the invention of the oxyhydrogen blowpipe, many substances were assumed to be infusible which now yield to its powerful action.

In 1837 Gaudin fused alumina into crystals resembling rubies and other precious stones of which alumina is the base. In 1847 Ebelmen, the manager of a Sevres porcelain factory, noticed that boracic acid sometimes volatilized in his furnaces. He commenced experimenting with boracic acid and alumina, which resulted in his obtaining shining crystals of extreme hardness, which he supposed to be oxide of alumina, but which were probably boron.

It is well known that carbon assumes three forms or conditions, which are "graphite," "charcoal," and the "diamond," or, as it would be expressed scientifically, *Graphitoidal*, *Amorphous*, and *Adamantine*. Wöhler and Deville have made elaborate experiments on boron, and found that it likewise exists in three forms like carbon, to which it exactly corresponds. Graphitoidal boron is obtained by subjecting a mixture of fluoborate of potassium with alumina to a high temperature. The amorphous form is prepared by strongly heating boracic acid with a small quantity of alumina, and boiling the residue in hydrochloric acid. It is a dull olive-green powder.

Adamantine boron is produced by submitting boracic acid and alumina in a charcoal-lined crucible, to a temperature at which nickel melts. Crystals of boron result, which are found imbedded in metallic aluminium. Some of the crystals are red; others yellowish. They are all extremely hard—almost as much so as the diamond itself. Corundum yields to the superior hardness of these crystals. If this substance could be produced cheaply, it might be substituted for the diamond for certain mechanical purposes.

Boron is among the least plentiful of the non-metallic elements. When freed from water, boracic acid forms a colorless, transparent, brittle glass, which fuses at a red heat; does not volatilize alone, but with water or alcohol at a high temperature it is partly volatilized. If fused in a platinum crucible and allowed to cool, cracks are formed, during which a vivid light is seen, even in the daytime. In solution, it reddens litmus paper slightly, and its mixture with sulphur burns with a green flame.

Hydrate of boracic acid is formed by heating crystals of boracic acid above 100° centigrade, when they lose a part of their water. All the borates, except those of ammonia, potash, soda, and lithium, are insoluble in water, or difficultly so.

The borates are not decomposed by ignition, with the exception of those with alkaline bases. The solutions are colorless, and all (even the acid salts) give an alkaline reaction.

BORATE OF ALUMINA

Is formed when a solution of borax is poured into one of common alum. It forms white pearly scales, sparingly soluble in water.

BORATE OF AMMONIA.

There are several compounds of this nature. Quadroborate is prepared by saturating a warm solution of caustic ammonia with boracic acid. As the solution cools slowly, this salt crystallizes out in clear irregular six-sided prisms. The biborate is prepared as above, but with excess of ammonia. During the process the temperature rises, and on cooling right rhombic octahedrons form. Cotton goods saturated with solution of borate of ammonia and dried are rendered non-inflammable.

BORATE OF BARYTA.

Chloride of barium throws down in solutions of the borates, if not too dilute, a white precipitate of *borate of baryta*, which dissolves in acids and in solutions of ammonical salts. This precipitate, from solutions of the neutral borates, has the formula ($BaO\ BO_3+aq.$), and from the acid borates ($3BaO,\ 5BO_3+6\ aq.$)

BORATE OF BISMUTH

Is a white, very heavy powder, insoluble in water. Its preparation is not given in the text-books.

BORATE OF CADMIUM

Is a white powder, difficultly soluble in water, which falls when solutions of borax and sulphate of cadmium are mixed. It has the following composition:

Oxide of cadmium	72.115
Boracic acid	27.885
	100.000

BORATE OF CHROMIUM.

Borate of chromous oxide is obtained by mixing solutions of borax and protochloride of chromium, a pale blue precipitate, soluble in free acids.

To produce the *borate of chromic oxide*, borate of ammonia is precipitated with sesquichloride of chromium. It is a pale green powder.

BORATE OF COBALT.

A reddish white powder obtained by the double decomposition of borax and chloride of cobalt, which may be fused to a beautiful blue glass. Oxide of cobalt fused with boracic acid yields a similar compound.

BORATE OF COPPER.

Solution of borax poured into a solution of sulphate of copper produces a voluminous pale green precipitate of borate of copper, slightly soluble in water, which may be fused to an opaque green glass.

BORATE OF IRON.

The *protoborate* is obtained by precipitating protosulphate of iron with borax. It is a pale yellow powder.

The *per borate* is an insoluble yellowish powder, vitrifiable at a high heat, which precipitates when solutions of per sulphate of iron and borax are mixed.

BORATE OF LEAD.

One hundred and twelve parts of oxide of lead fused with twenty-four parts of boracic acid yields a soft yellow glass which is a borate of lead. It may be also produced in the form of a white flaky powder by precipitating a lead salt with borax. This precipitate fuses to a transparent glass and has the following composition: $PbO + 2BO_3$.

BORATE OF LIME.

Borate of lime occurs in nature as ulexite, cryptomorphite, priceite, pandermite, colmanite, etc. In fact, there seems to be a strong affinity between boracic acid and lime. It may be prepared artificially by pouring a solution of borax into one of lime water. Borax precipitates lime salts, also, if they are not too dilute. These precipitates have the general properties of the natural borates of lime.

BORATE OF MAGNESIA.

There are several borates of magnesia: 1. Tri-borate; 2. Mono-borate; 3. Four thirds borate; 4. Ter borate.

1. Obtained by boiling solution of sulphate of magnesia with borax and washing thoroughly. At first it is gelatinous, but becomes white and solid, slightly soluble in water.

2. Aqueous solution of sulphate of magnesia and borax, boiled

together until they become turbid, and rendered clear by cooling, are set aside for some months, when crystals of the salt form.

3. Occurs only in nature as *boracite.*

4. Hydrate of magnesia in excess is boiled with boracic acid and water, filtered and evaporated; a crystalline crust forms, which is soluble in seventy-five parts of cold water.

BORATE OF MANGANESE

Precipitates as a white powder when borax and proto-sulphate of manganese, both in solution, are mixed. Care must be taken that there is no magnesia present as an impurity, for the borate of manganese is soluble in solution of magnesia.

The borate of manganese has been found to be a most excellent drier for paints, oils, and varnishes, and is coming into general use in the arts for that purpose. As manganese and borax are abundant and cheap in California, there seems to be no reason why it should not be extensively manufactured in the State. This subject is well worthy of the attention of some of our idle men and boys. Oil is boiled with the usual precautions, slowly at first, as water may be present; when so hot that it is certain that the water has been wholly driven off, the heat is increased. When sufficiently boiled, the borate of manganese is mixed with a little hot oil in a small vessel and added by degrees to the kettle, stirring all the while. When thoroughly mixed the kettle is covered and allowed to cool. There is no arbitrary rule for the quantity of drier to be used, as the requirements are not always the same. But three pounds of borate of manganese to 100 gallons of linseed oil has been used in practice and published.

BORATE OF MERCURY.

The proto-borate is obtained by mixing solutions of proto-nitrate of mercury and borax, and evaporating the solution. The result is a mass of small shining crystals.

BORATE OF NICKEL.

Borax throws down from solution of nickel salts a pale, apple green, precipitate of borate of nickel, insoluble in water, but soluble in sulphuric, hydrochloric, and nitric acids. It may be fused to a glass, of a hyacinth color.

BORATE OF POTASSIUM.

The *boride* obtained by heating the elements together in chemical proportions, has been examined, and found to be a mechanical mixture, and not a chemical compound.

The *borate* is formed when boracic acid and dry carbonate of potash are strongly heated together. It is fusible at a white heat; difficultly soluble in water, from which it does not crystallize.

The *biborate* is obtained by supersaturating carbonate of potash with boracic acid at a boiling heat; solution of caustic potash is added until the liquid is alkaline, when it is set aside to crystallize; the crystals are slightly alkaline to the taste, redden turmeric paper, swell with heat like borax, then fuse to a transparent colorless glass, and dissolve readily in hot and cold water.

BORATE OF SILVER.

Nitrate of silver produces, in concentrated solutions of neutral borates, a white or slightly yellow precipitate of borate of silver ($AgO\ BO_3+HO$); in concentrated acid solutions a similar precipitate ($3\ AgO, 4\ BO_3$). Dilute solutions of the borates give, with the same reagent, a precipitate of oxide of silver. All of these precipitates are soluble in nitric acid and in ammonia.

BORATE OF STRONTIA.

Borax in solution gives a precipitate with neutral salts of strontia. The precipitate is a white powder soluble in one hundred and thirty parts of boiling water; it dissolves also in a cold aqueous solution of hydrochlorate or nitrate of ammonia.

BORATE OF TIN

Is an insoluble white powder which fuses to a gray slag. Very little is known about it.

BORATE OF URANIUM.

To produce it, a solution of a uranic salt is precipitated with one of borax. It is light yellow in color, and sparingly soluble in water.

BORATE OF ZINC.

Aqueous solutions of sulphate of zinc and borax, when mixed together, throw down borate of zinc as a white powder, insoluble in water, but soluble in aqueous solution of boracic acid. It becomes yellow when ignited and fuses into a solid, compact, opaque slag.

BORATE OF ZIRCONIA

Is a precipitate formed by mixing solution of a salt of zirconia and borax. It is a white insoluble powder.

BROMOBORACIC ACID.

When vapors of bromine are passed over an ignited mixture of vitrified boracic acid and charcoal, a colorless gas is formed, which gives off white fumes in contact with moist air.

CHLORIDE OF BORON.

Chlorine gas is passed over perfectly dry boron, ignited in the large part of tube of glass or porcelain. The gas which forms is collected over mercury, and the free chlorine removed by agitation with mercury. It is a colorless gas, which gives off dense white vapors in contact with moist air.

FLUORIDE OF BORON

Is a colorless gas, incombustible, and not a supporter of combustion. It has a pungent odor. In contact with moist air it forms a white cloud. It is formed by gently heating one part of vitrified boracic acid with two parts of fluorspar and twelve of concentrated sulphuric acid in a leaden vessel. Great care should be taken in its preparation, as the gases are poisonous.

IODIDE OF BORON.

Vapors of iodine are passed over an ignited mixture of boracic acid and charcoal. A small yellow sublimate forms, which is probably iodide of boron; but of this there seems to be some doubt.

SULPHIDE OF BORON

Forms when boron is heated to redness in a vapor of sulphur. It is a white opaque substance.

FORMULÆ USEFUL IN CALCULATION.

Element.	Symbol.	Atomic Weight.
Boron	B	11.
Sodium	Na	23.
Oxygen	O	8.
Hydrogen	H	1.
Calcium	Ca	20.
Carbon	C	6.

COMPOUNDS.

Boracic acid, anhydrous. BO_3 = atomic weight 35

Boron	31.43 per cent
Oxygen	68.57 per cent
	100.00

Boracic acid, crystallized. $BO_3 + 3HO$ = atomic weight 62

Boracic acid	56.44 per cent
Water	43.56 per cent
	100.00

Borax, anhydrous. $NaO\ 2BO_3$ = atomic weight 101

Soda	30.70 per cent
Boracic acid	69.30 per cent
	100.00

Borax, crystallized, prismatic. $NaO\ 2BO_3 + 10HO$ = atomic weight 191

Boracic acid	36.65 per cent
Soda	16.23 per cent
Water	47.12 per cent
	100.00

Borax, crystallized, octahedral. $NaO\ 2BO_3 + 5HO$ = atomic weight 146

Boracic acid	47.94 per cent
Soda	21.23 per cent
Water	30.83 per cent
	100.00

Ulexite, $2CaO, NaO, 5BO_3+10HO$ = atomic weight — 352

Boracic acid	49.5 per cent
Lime	15.9 per cent
Soda	8.8 per cent
Water	25.8 per cent
	100.0

Carbonate of soda, anhydrous. NaO, CO_2 = atomic weight — 53

Soda	58.49 per cent
Carbonic acid	41.51 per cent
	100.00

Carbonate of soda, crystallized. NaO, CO_2+10HO = atomic weight — 143

Soda	21.67 per cent
Carbonic acid	15.39 per cent
Water	62.94 per cent
	100.00

EXAMPLES SHOWING THE USE OF THE FORMULÆ.

Let it be required to determine how much crystallized borax can be made from a certain quantity of anhydrous boracic acid, say 74 pounds.

As the percentage of boracic acid in prismatic borax (36.6) is to 100 so is 74 to the unknown quantity.

$$\frac{74 \times 100}{36.6} = 202+ \text{ pounds.}$$

The borax equivalent of borate of lime may be calculated as follows:

Percentage of boracic acid in—

Borax	36.6
Ulexite	49.5

$$36.6:100::49.5:\text{unknown quantity.}$$

$$\frac{49.5 \times 100}{36.6} = 135.2+$$

Therefore the boracic acid in 100 pounds of ulexite, if combined with soda and water, would yield 135.2 pounds crystallized prismatic borax.

ASSAY OF BORAX.

Simple tests serve to detect the usual foreign substances contained in borax. When pure it should dissolve in twelve to twenty-four parts of cold water to a clear solution without color or residue. A sample heated to fusion should leave a residue weighing fifty-three per cent, nearly. If adulterated with nitrate of potash it will deflagrate when thrown on burning coals. If alum is present as an impurity, its solution will react acid to litmus paper. Borax is often degraded by admixture of phosphate of soda, sometimes to the extent of twenty per cent, in which case its solution will give a yellow precipitate upon addition of molybdate of ammonia mixed with excess of nitric acid. Lime is indicated by a white precipitate, which falls when carbonate of soda is added to the solution. This precipitate dissolves in dilute hydrochloric acid with effervescence. Sulphate of soda and chloride of sodium (common salt), the natural impurities, are indicated, the former by a precipitate with chloride of barium in the presence of free acid, and the latter by the formation of a white curdy precipitate with nitrate of silver in the presence of free nitric acid. The latter precipitate is soluble in ammonia and is reproduced on the addition of an acid.

If to a solution of boracic acid, or an alkaline borate, hydrochloric acid is added to slight acid reaction, and a slip of turmeric paper half dipped into it and dried on a watch-glass at 212° Fahrenheit, the dipped portion shows a peculiar red tint; this reaction, which is delicate, must not be confounded with similar colors obtained from other substances; to avoid which, experiments should be made with pure solutions, carefully prepared, to educate the eye.

The flame test has been described elsewhere.

Borax may be determined volumetrically. For this assay a solution of sulphuric acid must be prepared, in which an exact chemical equivalent of the acid shall be contained in each litre. This acid solution, called "normal sulphuric acid," must be carefully preserved in a well stoppered bottle, as on its purity and uniform strength depend the accuracy of the results. An equivalent of the borax to be assayed (or rather what would be an equivalent if it were pure) must then be dissolved in distilled water.

Now if both solutions contain exact equivalents, they would neutralize each other if poured together. In a like manner, if a tenth of each solution were mixed they would neutralize each other. The tenth of a litre is a convenient measure for the assay, because it contains 100 cubic centimeters (C.C). If 100 C.C. of the acid solution neutralized the tenth of an equivalent of borax in solution, it would be evident that the sample was pure. If 80 C.C. only were required, the sample contains eighty per cent of borax. In other words, each C.C. of the acid solution represents one per cent of crystallized borax in the sample.

When litmus is added to a solution of borax, only a purple red color is seen while any borax remains undecomposed; but, upon adding sulphuric acid, at the instant that the last atom of soda is changed to sulphate, a light red color appears.

Upon these reactions, the volumetric assay is based.

It has been shown elsewhere, that the chemical equivalent of crystallized prismatic borax is 191. One tenth of this weight—19.1 grammes of the borax—is dissolved by shaking in cold water; 250 to 300 cubic centimeters will be required. The solution must not be filtered.

This solution is placed in a clean beaker, solution of litmus added until a deep color is imparted to the fluid. Normal sulphuric acid is then dropped in from a burette, graduated to 100 C.C. and tenths, until the color suddenly changes to a bright red. The first test may be made somewhat carelessly, as it will only be an approximation. The beaker is then washed out, and the operation repeated; this time with greater care. The result will be nearly correct. A third experiment will serve to verify the result. The reader should refer to some practical work on chemistry for description of the apparatus and method of making the test solutions. *Sutton's Systematic Handbook of Volumetric Analysis*, third edition, is one of the best.

Only borax can be estimated by this method. The determination of boracic acid in minerals and other substances, is extremely difficult, and can hardly be explained without an elaborate description, which may be found in text-books on analytical chemistry. In the volumetic method described above it is customary to deduct 0.5 C.C., to correct for the excess of sulphuric acid required to develop the red color in the assay.

USES OF BORAX AND BORACIC ACID.

The consumption of boracic acid and its salts is only limited by the supply. It is very largely used in the manufacture of pottery and earthenware as a glaze. In 1820, Mr. Wood, of Liverpool, applied boracic acid to the glazing of pottery, which has continued, with increasing consumption, to the present time.

The following mixtures are published. For common English porcelain:

Feldspar	45 parts
Silica	9 parts
Borax	21 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	111 parts

For figures and ornaments:

Feldspar	45 parts
Silica	12 parts
Borax	15 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	108 parts

The glaze is made by melting the ingredients together, and afterwards grinding them with water, into which the ware is dipped and dried. The articles are first partially burned, in which form they are called "biscuit."

Large quantities of borax are consumed in the potteries at Trenton, New Jersey; East Liverpool, Ohio; Philadelphia, and Cincinnati, and will eventually be used in prospective potteries in our own State.

Borax has lately been extensively applied to the manufacture of porcelain-coated iron ware, known as "granite ware."

Boracic acid is used in the manufacture of certain varieties of glass and in "*strass*," which is the base of artificial gems named after the inventor, Strass of Strassburgh, who lived in the seventeenth century, and who was the first to make artificial gems of this character.

The following is the composition of strass:

Pure silex	300 parts
Potash	96 parts
Borax	27 parts
White lead	514 parts
Arsenic	1 part
	938 parts

All the ingredients must be pure, specially the borax, which must be prepared from pure boracic acid. Tincal is not suitable.

The mixture is put into a Hessian crucible, and kept at the highest heat of a pottery furnace for twenty-four hours. The longer it is kept in a state of fusion the clearer and more homogeneous it will be when cooled. It is used by lapidaries for imitating diamond, topaz, and other white gems. For colored gems various metallic oxides are added in proportions only learned by experience. The coloring matter must be in the finest powder, and not only very intimately mixed, but the mixture must be very strongly heated, the heat must be long continued, and the cooling gradual.

It is stated in Parke's Chemical Essays that four ounces of borax and one ounce of pure fine white sand will make a pure glass, so hard as to cut common glass like the diamond.

The following formula is given of the brilliant greenish yellow glass of Sevres:

Silica	19.32
Protoxide of lead	57.64
Soda	3.08
Boracic acid	7.00
Protoxide of iron	6.12
Oxide of zinc	2.99
Antimonic acid	3.41
Potash	.44
	100.00

Vitrifiable pigments for glass staining and encaustic tiles are rendered fusible by admixture of borax. The following formulæ are given:

1. One part sand, three parts litharge, one third part borax. The borax must be fused in a platinum crucible and poured into water, and, when cold, ground fine.

2. One part sand, two and three quarters parts litharge, three eighths part borax. Heated as in No. 1.

3. One part sand, two parts litharge, one fourth part borax. Heated as in No. 1.

4. One part sand, three parts minium, one eighth part borax. Prepared as in No. 1.

5. Six parts white sand, washed, and heated to redness, four parts yellow oxide of lead, one part borax glass, one part saltpeter.

6. One part sand, two parts litharge, three quarters parts borax glass.

7. Eight parts white quartz sand, washed and calcined, four parts borax glass, one part saltpeter, one part white chalk.

In the art of enameling, borax is also largely used as a flux.

Borax has the property of dissolving the metallic oxides, which makes it useful in soldering metals. It renders the surfaces to be joined clean, so that the solder "runs" and fills the joint between them. For this purpose, as well as in welding iron, the octahedral is the most desired, as, containing less water, it sooner settles down quietly on the work. In soldering small articles, the borax is rubbed on a slab of slate with water, and the mixture put on with a camels-hair brush.

The same property is taken advantage of in blowpipe chemistry, to determine the presence of certain metals which may be in the substance under examination. A loop is prepared on the end of a thin platinum wire, in which borax is melted in the blowpipe flame; a small quantity of the substance in a fine powder is then introduced by wetting the borax bead and touching it to the powder. The bead is again subjected to the flame; first in the outer, and then in the inner flame, and allowed to cool while being closely observed.

BLOWPIPE REACTIONS.

	Outer Flame.		Inner Flame.	
	Hot.	Cold.	Hot.	Cold.
Yellow	Vanadic acid. Sesqui-oxide of iron. Oxide of lead. Ter-oxide of bismuth and of antimony.		Tungstic, titantic, vanadic, and molybdic acids.	
Red	Oxide of chromium. Sesqui-oxide of cerium.	Oxide of nickel.		Oxide of copper.
Violet	Sesqui-oxide of manganese. Oxide of cobalt containing manganese.			
Blue	Oxide of cobalt.	Oxide of cobalt. Oxide of copper.	Oxide of cobalt.	Oxide of cobalt.
Green	Oxide of copper.	Sesqui-oxide of chromium.	Sesqui-oxides of iron, chromium, and uranium.	Vanadic acid. Sesqui-oxides of iron, chromium, and uranium.

Borax has great detersive properties and is very useful in the laundry. The washerwomen of Holland and Belgium, so celebrated for their fine and white linen, have used borax as a washing powder for many years. They add borax in the proportion of half a pound to ten gallons of boiling water. For washing laces, cambrics, and even woolen blankets and other goods, it will be found very useful. It is also a valuable cosmetic, rendering the skin soft, and it is claimed it will prove a preventive and even a cure for certain skin diseases. It is an excellent shampoo, without any admixture except water, and is perfectly harmless. For cleaning brush and comb it will be found very useful. It is so essential to the toilet that a bottle of it should be kept always ready, prepared as follows:

A quantity of refined borax is shaken up in a bottle with water until no more will dissolve. The solution is then poured off into a clean bottle and half the quantity of water added, and both mixed by shaking. If not clear it must be left some time to stand and the clear portion poured off, or better still, filtered through paper. In this condition it may be added to a basin of water, used as a mouth wash, and other ways as described.

In medicine, according to the United States Dispensatory, borax is a mild refrigerant and diuretic. It is a remedy for nephritic and calculous complaints dependent on an excess of uric acid. Externally it is used in solution as a wash in scaly eruptions, and for other diseases.

Borax and boracic acid are used to render cream of tartar more soluble. The formula given in the French codex is as follows:

Four hundred parts cream of tartar, and 100 parts of boracic acid are dissolved in a silver basin with 2400 parts of water at a boiling heat. The solution is kept boiling until nearly all the water is evaporated. The heat is then moderated and the mixture stirred. When it has become very thick it is removed in portions, which are flattened in the hand, well pounded, and powdered. This is soluble cream of tartar.

A solution of borax is used as a gargle for sore throat and in colds, and it has been found effective in cases of epizooty in horses. In 1873, experiments were made in San Francisco which gave favorable results. The doses were four ounces daily, given pulverized in the food.

In hot climates a cooling drink is said to be prepared with bicarbonate of soda, tartaric acid, and borax. This statement wants confirmation.

In 1878 Smith Bros. sold 20,000 pounds of borax to Chicago consumers, to be used in preserving and canning beef.

Borax is used as a mordant in calico printing and in dyeing, and as a substitute for soap in dissolving gum out of silk; in solution as a wood preservative, and in the manufacture of soap. A varnish made by boiling one part of borax with five parts of shellac is used in stiffening hats. With caseine borax forms a substance which is used as a substitute for gum. A solution of borax in water may be mixed with linseed oil and used for cheap painting.

Borax is extensively used in assaying, in the metallurgy of ores, and in the smelting of copper, and it is said to be an excellent insecticide, being especially obnoxious to cockroaches.

There are probably other uses to which it has been put, and no doubt new applications will be found for it if the production should increase.

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CALIFORNIA STATE MINING BUREAU.

Henry G. Hanks, State Mineralogist.

FOURTH ANNUAL REPORT

OF THE

STATE MINERALOGIST

For the Year Ending May 15, 1884.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1884.

To his Excellency George Stoneman, *Governor of California:*

Sir: I have the honor herewith to submit to you the fourth annual report of the State Mineralogist of California, in compliance with section three of an Act of the Legislature, entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880.

I have the honor to be, very respectfully,

HENRY G. HANKS,
State Mineralogist.

San Francisco, June 15, 1884.

REPORT.

For the past year, satisfactory progress may be reported.

The Mining Bureau still continues to occupy the rooms No. 212 Sutter Street, although they are unsuited for the purpose, for the reason that the danger of fire is very great, as mentioned in the last two reports, and alluded to again because the State Mineralogist feels it his duty to warn the people of California of the danger of destruction by fire of the now very valuable Museum and Library, which could never be replaced if destroyed. It is to be hoped that the next Legislature will give this matter their serious consideration. The situation of the Museum over a stable causes other inconveniences, such as disagreeable ammoniacal and hippuric odors, and disturbance of arranged specimens in the cases, by the jarring made by the hoisting of hay by tackles attached to the under side of the Museum floor. The California State Museum is well worthy of a good and thoroughly fireproof building.

MUSEUM.

The Museum has grown beyond all expectation, and it is a question if any similar institution has gained so rapidly as this. This has been the subject of remark by strangers visiting the rooms, on being informed that the collections had been made within four years, and it is for this reason that the specimens have not been so fully classified as the management would wish. Specimens come in faster than they can be arranged and entered in the catalogue, and many fine, valuable, and interesting specimens have been temporarily laid away in drawers awaiting the careful attention that must be given, before they can be assigned to cases in the Museum. There are 6,000 specimens now on the catalogue, or arranged and ready for such entry.

PUBLICATIONS.

The three former reports have been wholly distributed. The rule adopted by the Mineralogist has been to deliver to all applicants, either personally or by letter, a copy of the report, unless he or she has already received one. A large proportion has been distributed by members of the State Legislature, and now many applications are received from the Eastern States and from abroad which cannot be supplied. The publications of the Mining Bureau should be sold at actual cost—a plan adopted by the State of Pennsylvania for the distribution of the publications of the Second Geological Survey, and the money resulting from the sale of publications returned to the State Treasury. Should this plan be adopted, more money should be placed at the disposal of the State Mineralogist, to enable him to furnish more information and to produce better reports by employing competent assistants, and means to travel within the State, to gather personally information bearing on the mineral interests of the State. All the reports thus far, have been made under great difficulty from causes set forth in former reports.

LIBRARY.

The Library now contains 257 works in 602 volumes. Of maps, atlases, views, and large photographs, there are 156; besides which there are a large number of pamphlets, circulars, mining companies' reports, proceedings of societies, etc., arranged in uniform shelf files. If these were bound, they would add largely to the Library. A catalogue of the books, maps, and photographs is now in the hands of the State Printer, and when printed will be the first library catalogue published.

The following newspapers have been sent to the Mining Bureau gratuitously:

1. Engineering and Mining Journal, New York.
2. Mining Record, New York.
3. Mining Review, Chicago, Illinois.
4. Economist, Boston, Massachusetts.
5. Daily Report, San Francisco, California.
6. Daily Grass Valley Union, Nevada County, California.
7. Daily Evening Gazette, Reno, Nevada.
8. Sierra County Tribune, California.
9. Humboldt Standard, Eureka, Humboldt County, California.
10. Inyo Independent, Inyo County, California.
11. Arizona Gazette, Phœnix, Arizona Territory.
12. Ventura Free Press, San Buenaventura, California.

No special effort has been made to add to the collection of books, but the importance of having an extensive library of reference on all subjects relating to mining, mineralogy, palæontology, and general geology, open to the public, has never been lost sight of. A few rare and important books have been obtained by purchase, a considerable number by donation, and others by exchange. Now that the publications of the Bureau are in demand, it is to be hoped, and it is confidently expected, that publications of foreign and domestic societies and institutions will be sent in exchange. Quite a number of such exchanges have already been received.

VISITORS.

The names of 14,165 visitors have been entered on the Museum Register up to May 15, 1884, the date of this report. This does not by any means indicate the number of visitors, for the reason that many do not care to enter their names, and many who frequently visit the Museum decline to register after the first time. If some method had been adopted from the first to register all who have visited the Museum, the number would have been very largely in excess of the entries.

DONATIONS.

The following is a list of donors who have contributed to the Museum during the past four years. Many have given a number of specimens, some have contributed largely, and many of the donations are of great value. The name of Mr. J. Z. Davis appears 368 times in the catalogue, although but once in this list. Other names appear many times. It would be impossible here to enumerate all the specimens given by each donor. This information can be gained by referring to the catalogue, or the museum cases:

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Shepard, Prof. C. W.
San Francisco Journal of Commerce.
Sherwood, Henry.
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Wand, T. N.
Ward, Prof. Henry A.
Ward, H. H.
Ward, W. E.
Wagoner, Luther.
Waller, T. P. F.
Watson, William H.
Wagner, Joseph.
Walker, Dr. D.
Watson, E. H.
Wallace, Thomas.
Wasson, Hon. Jos.
Waterman, J. S.
Wayson, James.
Webb, A. T.
Wellin, P. M.
Wegener, B.
Wellendorf, L.
Weir, James C.
West, D. W.
Wheeler, M. A.
Whittier, Fuller & Co.
Whisby, L. N.
White, D. Morgan.
White, Mrs. J. S.
Whitman, S.
Wilson, J. Downes.
Wilcox, A. O.
Wilcox, J. W.
Winder, W. A.
Williams, F.
Winall, Mrs. M. A.
Winall, S. A.
Williams, G. F.
Williams, Colonel A. F.
Wilson, W. H.
Wilson, J. F.
Wight, Captain J. N.
Wilkinson, Jos.
Williamson, Colonel R. S.
Williams & Blanchard.
Wilson, George R.
Winans, J. C.
Wightman Bros.
Wilkinson, J. W.
Winterburn, John
Woodbury, J. G.
Woodhull, S. D.
Woodward, R. B.
Woodward, E. W.
Wolverton, J. R.
Wolleb, E.
Woodley, W. J.
Worcester Royal Porcelain W'ks
Wright, Alfred.
Wright, J. E.
Wyman, G. D.
Wynants, N.

Yale, Charles G.
Young, J. W., Jr.
Young, William W.

Zuber, G. L.

STATEMENT OF RECEIPTS AND DISBURSEMENTS, STATE MINING BUREAU.

From May 15, 1880, *to May* 15, 1884, *inclusive.*

RECEIPTS.			
Bureau Fund			$25,972 44
Advances by Wells, Fargo & Co.			3,968 73
Warrants for State Mineralogist's salary			12,000 00
DISBURSEMENTS.			
Expenses:			
Rent	$8,675 00		
Safe	325 00		
General expenses	5,934 21		
		14,934 21	
Salaries:			
Secretary	$4,660 00		
Janitor	2,215 00		
Compilers and writers	710 00		
Chemist	1,125 00		
Copyists	127 50		
Museum attendance	123 70		
Labor	7 75		
		8,968 95	
Salary State Mineralogist		12,000 00	
Postage		224 75	
Museum		3,608 39	
Maps		160 35	
Library		345 00	
Traveling expenses		487 65	
Interest		1,130 65	
Cash on hand		81 22	
		$41,941 17	$41,941 17

SAN FRANCISCO, June 1, 1884.

I hereby certify that I have made a thorough examination of the books of the State Mining Bureau from May 15, 1880, to May 15, 1884, inclusive, and found the same to be correct.

EDWIN BONNELL, Accountant.

CHEMICAL WORK.

There is but little to report for this department. Since the discontinuance of laboratory work, and discharge of the efficient chemist—for want of funds—but little chemical work has been attempted beyond the examination of many minerals which have been sent in. This work has generally been done at odd times, mostly at night. The following is a record of analyses of minerals, etc., which are entered in the catalogue. The State Mining Bureau should be provided with a first-class chemical and metallurgical laboratory, and with funds to use in the employment of assistants, who should be engaged continually in the analysis of California minerals, ores, rocks, mineral waters, building stones, etc., and the results published annually as part of the report of the State Mineralogist. The want of a laboratory is daily realized. A chemical laboratory and library of reference should be considered the foundation of an institution such as the Mining Bureau was intended to be, and it will be impossible to make the institution worthy of the name without them.

ORE ASSAYS.

2034. Pyrite, containing gold and silver:

Gold, per ton	$51 00
Silver, per ton	222 00
	$273 00

3358. Copper Ore, Pioneer Mine, Bolinas Bay, Marin County:

Silver, per ton	$22 00
Gold	Trace
Copper	11 per cent

MINERAL ANALYSES.

1939. White Marble, Section 15, Township 13 north, Range 8 east, M. D. M., Placer County, California. This marble has been used in San Francisco for the generation of carbonic acid in the manufacture of artificial mineral waters:

Silica	.15
Sesquioxide of iron	.35
Lime	55.72
Carbonic acid	43.78
	100.00

2035. Cement rock, Washington Corners, Alameda County, California:

Silica	.05
Sesquioxide of iron	.16
Carbonate of magnesia	.65
Carbonate of lime	99.14
	100.00

2036. Arquerite—Silver amalgam, Vital Creek, British Columbia, latitude 53° north:

Mercury	11.90
Silver	86.15
Silica	.45
	98.50

2404. Stalactites (?) deposited by jets of steam at the Mud Volcanoes, Township 11 south, Range 13 east, San Diego County, California. Qualitative analysis shows carbonate of lime, with silica, iron, alumina, and magnesia, sulphuric acid in small quantities, and considerable common salt.

2443. Incrustation, Mud Volcanoes, Township 11 south, Range 13 east, San Bernardino Meridian, Colorado Desert, San Diego County, California:

Water	2.35
Chloride of sodium	1.26
Sesquioxide of iron	2.16
Sulphate of lime	1.79
Carbonate of lime	78.10
Carbonate of magnesia	2.84
Silica, clay, etc.	9.97
	98.47

1675. Concentrations from hydraulic washings, Jackson, Amador County, California—mechanical analysis:

Portion A—Coarse non-magnetic	56.6
Portion B—Fine non-magnetic	18.4
Portion C—Magnetic	25.0
	100.0

A—Contains garnets, sulphides of iron, various dark colored grains, and striated mineral, which, under the microscope, resembles selenite.

B—Is principally quartz sand. There are some amorphous particles of a red color, and the mineral resembling selenite.

C—Is almost entirely magnetite.

5213. Mechanical analysis of auriferous gravel, from Nevada hydraulic mine, Chalk Bluffs, Nevada County, California. (See Second Annual Report, 1882, folio 97):

	Per Cent.	Per Ct. Quartz.
Portion "A," zircon sand	00.01	------
Portion "B," large pebbles	39.80	89
Portion "C," coarse gravel	29.80	63
Portion "D," remained on No. 10 sieve	7.67	57
Portion "E," remained on No. 20 sieve	1.03	59
Portion "F," remained on No. 40 sieve	3.13	78
Portion "G," remained on No. 60 sieve	3.90	86
Portion "H," remained on No. 80 sieve	1.53	80
Portion "K," remained on No. 100 sieve	1.37	82
Portion "L," passed No. 100 sieve	1.47	72
Portion "M," slickens	10.29	N'ly all.
	100.00	

1883. Indurated Clay, corner of Filbert and Leavenworth Streets, San Francisco:

Silica	56.51
Alumina	21.33
Sesquioxide of iron	12.31
Lime	3.53
Water	6.30
Magnesia	Trace.
	99.98

1944. Clay, near Lincoln, Placer County, California. Called by the potters, blue plastic clay:

Silica	44.82
Alumina	34.54
Combined water	8.37
Hygroscopic water	1.27
Carbonate of lime	3.00
Magnesia	.96
Soda	4.74
Sesquioxide of iron	1.86
Loss	.44
	100.00

1945. Clay, near Lincoln, Placer County. Called by the potters, white non-plastic clay:

Silica	41.80
Alumina	38.78
Combined water	6.00
Hygroscopic water	1.62
Carbonate of lime	2.64
Magnesia	1.02
Soda	3.46
Sesquioxide of iron	2.12
Loss	2.56
	100.00

ANALYSES OF CALIFORNIA IRON ORES.

Catalogue Number.	Location.	Mineral Character.	Silica.	Ferrous Oxide.	Ferric Oxide.	Water.	Lime.	Sulphur.	Phosphorus.	Total.	Per Cent of Metallic Iron.
1761	Potters' Iron Mine, Shasta County	Magnetite	.49	19.59	79.90	----------	----------	----------	----------	99.98	71.16
1937	Red Hill, Placer County	Limonite	33.10	----------	55.25	9.35	1.65	Trace.	Trace.	99.35	38.68
1938	California Iron Co., Placer County	Magnetite	3.23	17.06	80.05	----------	----------	----------	----------	100.34	69.29
1996	Coulterville, Mariposa County	Magnetite	15.50	7.39	77.78	----------	----------	Trace.	----------	100.67	59.72
2274	Coast Range, San Benito County	Magnetite	14.70	18.72	65.40	.15	----------	Trace.	----------	98.97	59.74
4148	Near Latrobe, El Dorado County	Limonite	6.51	0.80	78.27	14.75	----------	.57	.02	100.92	55.41
1861	Clipper Gap, Placer County	Ocherous Limonite	5.70	----------	79.90	14.90	----------	Trace.	Trace.	100.50	55.93
----	Clipper Gap, Placer County	Limonite	9.28	----------	76.97	13.70	----------	Trace.	----------	99.95	53.88
----	Clipper Gap, Placer County	Limonite	7.16	----------	80.83	11.80	----------	Trace.	Trace.	99.79	56.58
----	Placer County	Magnetite	3.23	17.06	80.05	----------	----------	----------	----------	100.34	68.28

APPROXIMATE ANALYSES OF LIGNITES FOUND IN CALIFORNIA.

Catalogue Number.	Location.	Fixed Carbon.	Volatile Combustible Matter.	Water.	Ash.	Total.	Available Fuel.	Waste.
1800	Cienega del Gabilan Rancho, San Benito County	30.00	31.15	18.40	20.45	100	61.15	38.85
2334	Santa Clara Coal Mine, Los Angeles County	49.53	29.93	7.87	12.67	100	79.46	20.54
2378	Cajon Pass, San Bernardino County	46.53	27.67	9.67	16.13	100	74.20	25.80
2379	Telegraph Hill, San Francisco	16.50	----------	1.30	82.20	100	16.50	83.50
2513	Near Bieber, Lassen County	9.87	11.40	20.40	58.33	100	21.27	78.73
2533	Tejon Pass, Kern County	44.86	34.60	10.47	10.07	100	79.46	20.54
2910	Panoche Pass	31.54	31.73	13.73	23.00	100	63.27	36.73
4096	Near Lexington, Santa Clara County	47.00	29.50	16.50	7.00	100	76.50	23.50
4755	Near Mount Diablo, Contra Costa County	17.60	24.40 Including water.	----------	58.00	100	----------	----------
5045	Temescal Mountains, twenty-five miles southwest of Colton, San Bernardino County	27.74	32.26	20.00	20.00	100	60.00	40.00
5187	Willits, Mendocino County	41.75	19.00 Including water.	----------	39.25	100	----------	----------

PACIFIC COAST MINERAL EXPOSITION OF AUGUST, 1883.

This first attempt to represent the bountiful mineral resources of California in particular, and the Pacific Coast in general, was the result of the citizens' meeting of March 26, 1883, called by the State Mineralogist to take into consideration the future of the State Museum. While the meeting did not accomplish directly the end for which it was called, it resulted in good to the State and added largely to the collections in the Museum.

The preliminary steps taken by the committees are recorded in the Third Annual Report. The occasion of the Mineral Exposition was the meeting at San Francisco of the Triennial Conclave of Knights Templar of the United States. It was considered that intelligent representatives from every part of the Union would meet in San Francisco, and would expect to be shown the natural resources of the State, and that many persons not connected with the Order would visit California at the same time, making the occasion one of special fitness.

In response to circulars, many specimens were sent to the Museum, some as donations, others as loans. Several counties appropriated money to furnish special cases in which to display county specimens. To enable the management to arrange the exhibits, the Museum was closed to the public for a few weeks. The exposition was formally opened on the morning of August 15, 1883. Lieutenant-Governor John Daggett addressed those who were present as to the value of the exposition. He enlarged on the extraordinary mineral wealth of California, and the importance of making it known to the world, and the fitting occasion afforded by the meeting of the Triennial Conclave. Then, on behalf of the State, he declared the exposition open, and delivered the special exhibits into the charge of the State Mineralogist.

Besides the large collections of the State Mining Bureau arranged and in cases, all the specimens in process of classification were provided with temporary written labels and placed on tables and in twenty-four cases hired for the occasion. The exhibition attracted much attention, and was largely visited both by citizens and strangers.

Italian Collection. This collection has been acquired by exchange and by purchase. It fills four cases, and consists of minerals, ores, rocks, including ancient and modern marbles, fossils, etc. The Italian citizens of San Francisco evinced considerable interest in this collection, and added to it by loaning a fine Italian flag and photographs of ancient buildings in Rome.

Part of the Honduras collection, consisting of antiquities, woods, etc., was left by President Soto during the Exposition. The antiquities have since been removed, but duplicate samples of the woods were donated, and form an attractive feature in the State Museum.

On application, the Chief of Police detailed two officers, W. J. Shaw and G. W. Curtis, who remained in charge night and day during the Exposition. Nothing was lost or stolen.

John Meelen loaned a large American flag, which was hung in the Museum.

The following counties furnished money to purchase special county cases in which to exhibit the mineral resources of each: Butte, 2 cases; Inyo, 2 cases; Mono, 2 cases; San Bernardino, 2 cases; Tuolumne, 1 case; Humboldt, 1 case; Calaveras County sent the money for 2 cases, which, through a mistake, did not reach the management until after the Exposition closed.

The following list of the most important special exhibits, gives also the names of those who made them:

Adams and Carter. Frue concentrator. The whole apparatus was set up in the Museum. The apparatus is for the concentration of "slimes," and finely crushed material; for treatment of gold and silver mill tailings, and direct concentration of ores of silver, lead, copper, tin, zinc, etc., after stamps or pulverizers. It is automatic, and requires but little power or attention. Nearly 600 are now in use, manufactured in San Francisco.

M. P. Boss. Two highly finished mechanical drawings, designed by him and executed by *D. J. Osborne.* One showing the details of the Boss continuous system of pan amalgamation. The second a side elevation of the same. This process was first introduced into the Noonday mill at Bodie, Mono County, in May, 1880.

A. C. Bowen. Crystals of gold. Banner mine, near Michigan Bluffs, Placer County. Two pieces, the largest of which was a paneled octahedron, weighing 30.6 grams, one of the finest ever found in the State. The smaller was a flat piece covered with small octahedral crystals. Loan.

A. L. Burbridge. Three large specimens of silver ore, coated with embolite. Etna mine, Globe District, Pinal County, Arizona. Loan.

William Cameron. Ores containing free gold, with pyrite. Hidden Treasure mine, Placer County.

J. H. Carmany. Free gold in porphyry, associated with pyrolusite. Banghart mine, Shasta County, California. Magnificent specimen. Loan. Gold specimens. Mad Ox mine, near Washington, Shasta County, California. Loan.

John Daniel. Granite vase, from Lee's quarry, Placer County, California. Loan.

J. Z. Davis. Four cases containing specimens from his private collection, selected for their beauty, rarity, and interest. Also, many curiosities of great interest from his private collection. The exhibit was one that attracted much attention, and although entered as a loan, it still remains in the Museum. Gold watch, made in Dublin 120 years ago. Loan.

N. Dodge. Placer gold of unusual shape. Also, wire silver and gold in quartz. Loan.

W. E. Duncan. Specimens of gold quartz. Butte County, California. Loan.

Mrs. M. Durden. California woods, and an oil painting of Sutter's Mill, El Dorado County, the locality at which gold was first discovered. Loan.

Thomas Ewing. Providence Mountain, San Bernardino County. One case of rich silver ores from the mines which he is now successfully working. Ores, Belle McGillivray mine; suite of typical specimens. Providence Mountain. Ores from Bonanza King. Bonanza King Consolidated Mining Company, of New York. Providence Mountain. A full suite of very rich specimens from all the workings. All the specimens and the case containing them were donated by Mr. Ewing.

N. C. Fassett, Superintendent. Silver ores from the Belmont mine, Belmont, Nevada. Assay value, $4,000 per ton. Loan.

Louis Glass, Cherokee, Butte County. Specimens representing hydraulic mining at Cherokee. Blue gravel, bottom stratum, 6 to 10 feet thick. Yellow or rotten bowlders, from 1 to 10 feet thick, rich in gold, overlying blue gravel. White top gravel, 20 to 400 feet thick, overlying rotten bowlders. Basalt capping overlying white top gravel. Donation. Specimens of hydraulic gold, from large nuggets to the finest of placer gold. Loan. Gold amalgam, before retorting. Loan. Gold amalgam, after retorting, called retorted amalgam. Loan. Diamondiferous sand or gravel. Platinum found with gold in cleaning up. Donation. Placer gold and black sand clean up. Loan. Diamonds, cut and uncut, found in the mine from time to time—very interesting specimens. Loan.

A. J. Howth. Thinolite. Mono Lake. A fine specimen. Contributed.

Hunt and Chace. Harris dry gold separator. The complete machine was on exhibition. It is so constructed that it can readily be taken apart and packed in small space. The machine is turned by hand. Two currents of air are produced, while the dry material is agitated; one assists in the agitation, the other carries off the lighter particles. Capacity claimed is 20 to 30 tons per day, and the cost of the machine is $150 to $250.

D. B. James. Full-sized mining car for use in tunnels, drifts, etc. Loan.

Josiah Keep, Alameda, California. California shells and a book published by him on conchology. Loan. The shells were principally from Monterey Bay, but also from other localities. The work, "Common Sea Shells of California," contains 16 plates, illustrating about 100 California species, from drawings made from nature.

Marcus Laville. Plumbago, Tuolumne County.

John Leechman. Placer gold, Cave Diggings; Sections 28 and 29, Township 1 north, Range 16 east, Tuolumne County, California; in Limestone belt. Loan. A full suite of the ores and wall rock of the Soulsby mine, Tuolumne County. Donation.

W. N. Martin. Very fine specimens of free gold in quartz, from the New El Dorado gold mine, Greenwood Township, El Dorado County, California, formerly known as the North Cederberg. Loan.

Alvin Mathis. One case private collection, consisting principally of specimens from California quicksilver mines. Sixty-four fine specimens, many beautifully crystallized. Loan.

B. B. Miner. Gold specimen. Fine Gold Gulch, thirty miles east of Madera, Fresno County, California.

F. E. Monteverde. Rare and beautiful specimens, as follows. Loaned: Gold in calcite, Calaveras County. Gold crystals, Calaveras County. Gold crystals, White Bull mine, Linn County, Oregon.

Joseph L. Moody. Special case of very rich gold specimens from the Four Hills gold mine, Sierra County, California. Loan.

This was a remarkable exhibit, the value of the gold in the specimens was estimated at $10,000. In some there was more gold than quartz in all a striking illustration of the richness of some of the gold mines of California.

W. D. Minckler. Susanville, Lassen County. A collection of interesting specimens. Donated. Pebbles from Pyramid Lake shore. Red obsidian; tourmaline in quartz; jasper in several varieties; arrowheads, etc.

H. H. Noble. Large and magnificent specimen of silver ore, with much native silver, and crystals of polybasite. Silver King mine, Pinal County, Arizona. Loaned. Also fine specimens crystallized native silver, same mine.

A. B. Paul. Placer gold. Red Hill hydraulic mine, Butte County, California. Loaned. Masonic lambskin apron, worn by Masons one hundred years ago. Loan. Placer gold, west branch of Feather River, Butte County, California. Loan. Relics, objects, and manuscripts, bearing on the early history of the Comstock silver lode, Nevada, framed and glazed; a very interesting collection. Loan.

L. Radovich. Two cases ores and minerals, and fine specimen native silver, from Nevada. Also, working model of rock-breaker. Loan.

J. B. Randol. Specimen of cinnabar weighing 290 pounds, nearly pure, from New Almaden Quicksilver Mine, Santa Clara County. Donation.

Large iron dish filled with metallic mercury (quicksilver), New Almaden mine. Loan. This exhibit attracted special attention. A large iron bolt weighing several pounds floated on the surface of the liquid metal. Hundreds, if not thousands, of visitors thrust their hands beneath the surface. Ladies with gloved hands caught the infection, and could not be restrained from lifting handfuls of the bright metal, and allowing it to run in silver streams between their fingers. Some would remove their gloves, and, although warned of the effect, would plunge their ringed hands beneath the surface, and were surprised on removing them to find that their gold rings had turned white from amalgamation with the mercury.

I. I. Rapp. Gold in quartz. "Our Flag" mine, Carson Hill district, Calaveras County. Loan.

Nathan Rhine. Very rich specimen of gold quartz from the Keynot mine, Beveridge District, Inyo County, California, in elegant case. Loan.

S. Ruffino. Ten specimens ores, various, from West Point, Calaveras County, California.

E. F. Russell and *E. F. Barber.* Specimens of steel made from black sands of California: 1. Specimen black sand steel produced by the Russell process, hammered, also welded three times, and ground off to show the weld. Loan. 2. Cold-chisels from black sand steel, and iron cut by the same. 3. Steel wire from the same. 4. Specimens of the sand from which the steel was made.

Geo. E. Schenk. Poor Richard Almanac, 1773; Maryland and Baltimore Journal and Advertiser, August 20, 1772; Autograph letter from Dr. Benjamin Franklin to James Searle, Amsterdam, dated Passy, France, November 30, 1780. Copy of Patrick Henry's speech, July 4, 1776. Loan.

Colonel R. B. Stockton. Ore rich in free gold, and sulphurets. Stockton mine, near Madera, Fresno County, California.

J. P. Stanley. Santa Rosa. Two large cases filled with fine specimens of minerals, ores, rocks, fossils, etc., with ethnological specimens of great interest. Loan. A private collection gathered during many years of residence in California. The collection contained specimens from other countries, as well as California. The cases attracted much attention.

Mrs. H. F. Thomson. Four specimens gold-bearing quartz and one specimen copper sulphurets. Bully Choop, Trinity County, California.

W. J. Tustin. Tustin's rotary pulverizing mill represented by elaborate drawings.

J. D. Walker. Calaveras County. Irish copper coin. Loan.

H. W. Walker. Improved cupel mold. It has a convex edge to the bowl, which allows the mold to clear itself. The plunger does not require cleaning. From 10 to 12 dozen can be made in an hour. Samples of the cupels also were exhibited.

Ward and Blackwell. Placer gold from their deep gravel mine, Snow Point, Nevada County, California. Very coarse gold and nuggets. Loan.

Mrs. William Watts. Specimens of silicified wood, very fine. Iowa Hill, Placer County, California.

S. D. Woodhull. Independence. Three cases of minerals, ores, etc., from Inyo County, California, being his private collection made during a number of years' residence in that very interesting locality. Loan. This was a very attractive and instructive exhibit, showing at a glance the wonderful mineral resources of Inyo County.

——— Five specimens of gold, with cinnabar, from the Manzanita mine, Sulphur Creek, Colusa County, California. Loan.

STATEMENT OF RECEIPTS AND DISBURSEMENTS.

Citizens' Committee, Pacific Coast Mineral Exposition.

1883.	RECEIPTS.	
June 14	Butte County, by Louis Glass	$100 00
20	Boyd & Davis, Thurlow Block	250 00
24	J. M. McDonald, Pacific Bank	50 00
	Joshua Hendy, Mission and Fremont Streets	5 00
	Geo. Schmidt, Fountain Saloon	5 00
	Inyo County	100 00
	Mono County	100 00
	San Bernardino	50 00
	Tuolumne County	50 00
Aug. 16	Collected by S. Hydenfeldt, Jr.	25 00
	Citizens of Patterson District, Mono County, collected by M. Jones, as follows:	
	Dr. G. M. Summers	5 00
	Martin Jones	1 00
	M. A. Herne	1 50
	Chas. Dupee	1 00
	E. D. Ebi	1 00
	Henry Williams	1 00
	James Garaway	1 00
	Geo. Kinney	1 00
	B. S. Brown	1 00
	D. R. Avery, Center Market	5 00
	D. A. Terry, Center Market	2 50
Oct. 25	Humboldt County	50 00
	Advanced by J. Z. Davis	19 85
		$825 85

1883.	DISBURSEMENTS.	
July 12	Postage stamps	$3 00
20	Glass dishes	40
	Glass dishes	45
	Freight	1 70
21	Freight, Mono County	4 75
22	Labor, carrying large specimen of cinnabar upstairs	50
24	Cartage on mine model	1 25
26	Freight from Bodie	7 50
	Freight, Stanley collection	2 25
28	Delivering notices and papers	25
	Expenses on cases	1 45
Aug. 9	Freight on case from Humboldt	3 40
Sept. 1	Cherry & Johnson, bill of painting	26 00
	Cartage on Silver King specimen	50
Aug. 18	Daily Exchange, advertising	7 50
July 28	Wm. Proll, making 13 cases	494 00
May 1	Bacon & Co., printing	43 25
7	Wm. Proll, cases and tables	106 15
	Robinson & Gilespie, carpenters	64 05
Oct. 27	Wm. Proll, Humboldt County case	40 00
	Sundry small expenses	17 50
		$825 85

HISTORY OF THE GEOLOGICAL SURVEYS OF THE STATE.

The United States Exploring Expedition, under command of Captain Charles Wilkes, 1838-39-40-41-42, visited California and Oregon. James D. Dana was Geologist, and his observations are given in the reports.

Duflot de Mofras explored Oregon, California, and the Vermilion Sea during the years 1840-41-42. His report was published in Paris in 1844.

John C. Fremont explored Oregon and California in 1843 and 1844. The geology and palæontology were worked up by James Hall, of New York, and published in appendix to report of 1845.

Bayard Taylor came to California in 1849. A report of his observations appears in "El Dorado, or Adventures in the Path of Empire," New York, 1850. In the appendix report to Hon. T. Butler King, the metallic and mineral wealth of the State are considered.

The first writing on the geology of California after the discovery of gold, seems to have been a short report to the Secretary of War on the geology and topography of California by Philip T. Tyson. (Ex. Doc. No. 47 to the Senate of the Thirty-first Congress.) Manifee & Co., of Baltimore, published a reprint of this report in 1851. He examined the country from Benicia to the American and Calaveras Rivers in 1849, during the delirium of the gold fever. Mr. Tyson came to California with T. Butler King, who was sent out by the United States Government, on the discovery of gold being made known.

James S. Wilson, a practical gold miner, published a paper on the same subject, in the Quarterly Journal of the Geological Society of London about the same time.

The United States Government sent out an expedition to explore for a route for a railroad from the Mississippi River to the Pacific Ocean, under the orders of the War Department, in 1853-54. Of the reports, generally known as the Pacific Railroad Reports, twelve large volumes were published. One of the expeditions planned by the Government to explore the newly acquired western possessions of the American Union, and to determine the most practicable railway route from the Mississippi River to the Pacific Ocean, was organized for California, to explore the Sierra Nevada from Walker's Pass southward to the boundary, to ascertain the best and available mountain passes. This was placed under the command of Lieutenant R. S. Williams, Topographical Engineers, with J. G. Parke second in command, and through the recommendation of the Smithsonian Institution, Mr. W. P. Blake, a graduate of the Scientific Department of Yale, was appointed Mineralogist and Geologist. The party left Benicia Barracks early in the Summer of 1853, and made a continuous reconnaissance to the Tejon and Walker's Pass, passing through Livermore's Valley, the San Joaquin Valley, the Tulares, and following as near as possible to the foothills of the Sierra Nevada.

Detailed surveys were made of several of the passes and the adjacent country. The topography of that region was first ascertained, and for the first time delineated upon any map. The geology was determined and mapped also, and the first geological section of the Sierra Nevada was drawn. The explorations were extended southward along the mountains to San Bernardino, and to the boundary line. Amongst other results may be mentioned the discovery of eocene and miocene tertiary beds, and the determination of the ancient lacustrine formation of the Tulare Valley, and of the valley of the Colorado Desert. The barometrical observations from San Bernardino to Camp Yuma on the Colorado, were taken by Mr. Blake, and he announced the fact that an extensive area of the desert was below the sea-level, a conclusion that the commander of the expedition was reluctant to admit.

The results of the season's work, and of operations made in the gold region in the year 1854, were embodied in a report to the United States Government, and were finally published in a quarto volume, entitled: Report of a Geological Reconnoissance in California, etc.; by William P. Blake; published in the series of quarto reports on the explorations of the routes for a railway to the Pacific, and separately by the author; New York, 1858, pp. xviii+370+xiii, with plates of fossils, geological sections, and a geological map of California.

An article on the extent and geology of the gold region was also contributed to the American Journal of Science, and during a subsequent residence in California in 1860–1867, and the occupation of a Professor's chair in the College of California, several articles were contributed to the California Academy of Sciences. Professor Blake, in his first report, gave the first notice and sketches of the High Sierra, as seen from the Four Creeks, directing attention to the great altitude of the peaks, and to the peculiar serrated outline of the range in that region.

Professor Blake was appointed the Geologist of the State Board of Agriculture in 1866, and made a report on the minerals of the State.

Annotated Catalogue of the Principal Mineral Species hitherto recognized in California and the adjoining States and Territories, March, 1866. 8vo., pp. 32.

The secondary age of a part at least, of the gold-bearing rocks of California, was discovered and announced in 1863 and 1864, by Professor Blake. *Proc. Acad. Nat. Sci. Cal., Oct. 3, 1864.*

On the fifth day of March, 1853, the California State Legislature passed a joint resolution, calling on Doctor John B. Trask for such information as he might possess, relative to the geology of the State, the result of which was a "report on the geology of the Sierra Nevada, or the California Range," thirty-one pages, of which two thousand copies were ordered printed. On the sixth day of May, of the same year, a joint resolution was passed authorizing further geological examination of some parts of the Sierra Nevada and coast mountains, and providing that a report of the results should be presented to the next Legislature. Doctor John B. Trask was appointed first State Geologist. The second report by Doctor Trask contained ninety-five pages, entitled "report on the geology of the coast mountains, and part of the Sierra Nevada, embracing their industrial resources in agriculture and mining," and was presented to the Assembly, session of 1854, John Bigler, Governor.

Jules Marcou, a French Geologist, visited California in 1854, an account of which he published in the Bibliothequé Universal de Genéve in 1855.

The third report of the State Geologist, entitled, "report on the geology of the coast mountains, embracing agricultural and mineral productions; also portions of the middle and northern mining districts," ninety-two pages, was presented to the Assembly, session of 1855; John Bigler, Governor; John B. Trask, State Geologist.

The fourth report was made to the Assembly, session of 1856, and was entitled, "report on the geology of Northern and Southern California, embracing the mineral and agricultural resources of those sections, with statistics of the northern, southern, and middle mines;" J. Neely Johnson, Governor; John B. Trask, State Geologist.

In 1860 an Act of the Legislature, approved April twenty-first by John G. Downey, Governor, was passed entitled "An Act to create the office of State Geologist, and to define the duties thereof." Section one appointed J. D. Whitney State Geologist, to make with assistants an accurate and complete geological survey of the State, to describe in reports and maps the rocks, fossils, soils, minerals, botanical and zoölogical productions, and to collect specimens to be deposited in some place to be provided by the Legislature. Section four provided that the reports should be sold to the best advantage, and the moneys derived from the sale to be placed in the Common School Fund of the State. Section eight set apart $20,000 out of any money not otherwise appropriated, as a special fund for payment of expenses incurred by the survey.

W. H. Brewer and William Ashburner came to the State with Professor Whitney, and arrived November 14, 1860.

Mr. C. F. Hoffman joined the survey March 20, 1861, and commenced work as a topographical assistant.

July 1, 1861, Dr. J. G. Cooper was appointed zoölogist of the survey.

Early in 1862 W. M. Gabb arrived in California, and became palæontologist of the survey.

A. Rémond became a volunteer assistant in 1862, and continued with the survey until the end of 1863.

V. Wackenreuder held the position of topographical assistant during 1862 and 1863.

In 1863 Clarence King joined the survey as volunteer assistant in the geological field work.

In 1864 J. T. Gardner was volunteer assistant in topographical field work.

The appropriation from the commencement in April, 1860, to April, 1864, was $70,000.

In 1864 a second Act of the Legislature was passed reappointing Professor J. D. Whitney State Geologist, approved April fourth, by Frederick F. Low, Governor.

In 1864 the first volume of Palæontology was published, and in 1865 the volume on General Geology.

H. N. Bolander was connected with the survey in 1866 in the department of botany.

In 1869, volume two Palæontology was published.

In 1870, the Yosemite Guide Book and volume one Ornithology were published.

The Legislature of 1873–74 declined to make further appropriations, which of course discontinued the survey.

The State Geological Survey, so well and ably conducted by Professor Whitney and his staff of efficient assistants, was and is a great credit to California, and is so judged by those competent to express an opinion, the world over. Its abrupt termination was a misfortune not only to California but to the world, and a lamentable mistake. The ability of Professor Whitney, and his industry and integrity, have never been questioned even by those who differed in opinion as to the manner of his work. The censure implied by the discontinuance of the survey was an injustice to him. The only objection ever made was, that his work was not practical in the sense intended by the Act of Legislature which created the survey. Did the Legislature fully realize the following considerations? When Professor Whitney was appointed State Geologist, California was almost a *terra incognita*, in a geological sense; the surveys of Dr. Trask and those of the Pacific Railroad Engineers sent out by the Government, and the researches of the California Academy of Sciences lifted the margin of the vail which had hidden the geology of California from the world, and a glimpse only had been obtained of the mineral wealth of the State; the Government land surveys had not been completed; there were no railroads; hostile bands of Indians defended the mountain passes against prospector and surveyor alike; the area of the State was greater than that of any other in the Union except Texas, one hundred and twenty times as great as Rhode Island, three and one third times that of New York, and twenty times that of Massachusetts; there were snowy and almost inaccessible mountains and burning deserts to cross. These difficulties had to be surmounted. Since those days things have changed. The whole country is to a certain extent prospected; good mountain roads have been built on which lines of stages run daily; the most distant parts of the State are accessible by railroads; the cost of labor and necessities has diminished; the results of pioneer surveys have been tabulated and put into available form. Still, geology and mining in California are as yet in their infancy. Many, many years must elapse before we shall fully understand the geology and realize the magnitude of the mineral deposits within the area which we now call the State of California.

The foundation, so well laid by the State Geological Survey, will serve to build all future and more detailed surveys upon. The reports and maps of the survey, and the great State map, made by the present State Engineer, must for all time be the base for future surveys, be they geological, geographical, or agricultural. All we can do, will be to broaden the foundation already laid, leaving the completion of the superstructure to those who will follow.

Immediate practical results should not be expected, except to a limited extent, but the vast field presented, and the magnitude of the work undertaken, duly considered.

The Geological Society of London, from which may be dated the commencement of the geological survey of Great Britain, was organized in 1807. William Smith, who has been called the father of English Geology, had previously (in 1793) published a geological map of part of England, which was probably the first geological map ever made. The geological survey of France was ordered by the French Government in 1822. These surveys are not yet finished. What, then, can be expected from California, a new country, possessing sixty-eight thousand square miles more of area than Great Britain? The geological survey of California should be continued; the State can well afford it, but cannot afford to neglect it.

The publications of J. D. Whitney's survey are Geology, Volume 1, from 1860 to 1864, printed in Philadelphia in 1865, 498 pages, many wood engravings and plates.

Palæontology, Volume 1. Carboniferous and Jurassic Fossils, by F. B. Meek; Triassic and Cretaceous Fossils, by W. M. Gabb; Philadelphia, 1864; 243 pages, 32 lithographic plates of fossils.

Palæontology, Volume 2. Cretaceous and Tertiary Fossils; W. M. Gabb, Philadelphia, 1869; 299 pages, 36 lithographic plates of fossils.

Ornithology, Volume 1. Land Birds. Edited by S. F. Baird, from notes by J. G. Cooper, M.D; 592 pages, with many wood engravings; University Press, Cambridge, 1870.

Botany, Volume 1. Polypetalæ, by W. H. Brewer and Sereno Watson; Gamopetalæ, by Asa Gray; University Press, Cambridge, 1880; 628 pages, no engravings. Published by the liberality of the following California gentlemen: Leland Stanford, D. O. Mills, Lloyd Tevis, J. C. Flood, Charles McLaughlin, S. C. Hastings, R. B. Woodward, William Norris, John O. Earle, Henry Pierce, Oliver Eldridge.

Botany, Vol. 2, by Sereno Watson; University Press, Cambridge, 1880; 559 pages, no engravings. Published by contributions from S. C. Hastings, D. O. Mills, Henry Pierce, Leland Stanford, J. C. Flood, and Charles Crocker.

Contributions to American Geology, Volume 1. The Auriferous

Gravels of the Sierra Nevada of California, by J. D. Whitney; University Press, Cambridge, 1880. The Museum of Comparative Zoölogy at Cambridge assumed a portion of the expense of publication. From Notes made during the Continuance of the Geological Survey and Re-examination, by Professor Pettee, in 1879; University Press, Cambridge, 1880; 569 pages, with numerous maps and plates.

The Yosemite Guide Book; J. D. Whitney, State Geologist; Cambridge, 1870; 155 pages; with numerous wood engravings and map.

Several other publications of minor importance were issued by the Survey, such as bulletins, catalogues of shells and fossils, etc.

The State Mining Bureau and office of State Mineralogist were created by an Act of the Twenty-third Legislature of California, entitled an Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880, George C. Perkins, Governor.

The bill was introduced by Hon. Joseph Wasson, representing the Counties of Mono and Inyo.

The Act is published in full in the first report of the State Mineralogist, December 1, 1880.

Henry G. Hanks was appointed State Mineralogist May 15, 1880, his term of office to continue for four years. The history of the Mining Bureau, and the State Museum, will be found in the reports as follows:

First report, from June 1 to December 1, 1880, 43 pages.

Second report, December 1, 1880, to October 1, 1882, 514 pages, with map.

First Catalogue of the Museum, for the year ending April 16, 1880, 350 pages.

Third annual report for the year ending June 1, 1883, 137 pages, with map.

The present is the fourth and last report of the State Mineralogist. This sketch is intended to be a brief history of the most important facts relating to the development of a geological knowledge of the State.

In the following Government publications the geology and mineral productions of California have been duly considered, and much valuable information given:

By J. Ross Browne: Report on the Mineral Resources of the States west of the Rocky Mountains; House of Representatives, Thirty-ninth Congress, Washington, 1867, Ex. Doc. No. 29.

Report on the Mineral Resources of the States and Territories west of the Rocky Mountains; Washington, 1868.

By ROSSITER W. RAYMOND: Mineral Resources of the States and Territories west of the Rocky Mountains; House of Representatives, Fortieth Congress, Ex. Doc. No. 54; Washington, 1859.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains; House of Representatives, Forty-first Congress, Ex. Doc. No. 207; Washington, 1870.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains for the year 1870; House of Representatives, Forty-second Congress, Ex. Doc. No. 10; Washington, 1872.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the fourth annual report; Washington, 1873.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the fifth annual report; House of Representatives, Ex. Doc. No. 210, Forty-second Congress; Washington, 1873.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the sixth annual report; Washington, 1874.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the seventh annual report; House of Representatives, Forty-third Congress, Ex. Doc. No. 177; Washington, 1875.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the eighth annual report; Washington, 1877.

By HORATIO C. BURCHARD: Report of the Director of the Mint upon the Statistics of the Production of the Precious Metals in the United States; Washington, 1881.

Report of the Director of the Mint upon the Production of the Precious Metals in the United States; Washington, 1882.

Report of the Director of the Mint upon the Production of the Precious Metals in the United States; Washington, 1883.

By ALBERT WILLIAMS: Mineral Resources of the United States: Washington, 1883; Department of the Interior; United States Geological Survey, J. W. Powell, Director; Washington, 1883.

By TITUS FEY CRONISE: The Natural Wealth of California. The history, geography, climate, agriculture, geology, zoölogy, botany, mineralogy, mines, manufactures, etc., of the State; San Francisco, 1868.

By JOHN S. HITTELL: The Resources of California, comprising the society, climate, scenery, commerce, and industry of the State; San Francisco, 1879, with appendix and map.

CALIFORNIA.

INFORMATION, GENERAL AND STATISTICAL,

IN RELATION TO THE

AGRICULTURAL, COMMERCIAL, MANUFACTURING,

AND OTHER

RESOURCES, INTERESTS, AND INDUSTRIES OF THE STATE.

The Statistical Matter in this Part of the Report has been Gathered and Compiled by

HENRY DEGROOT.

RESOURCES OF CALIFORNIA, ETC.

GEOGRAPHICAL POSITION, AREA, AND NATURAL SUBDIVISIONS OF LAND.

California is situated between latitude 32° 45′ and latitude 42° north, and between the 38th and the 47th meridians west from Washington, being bounded on the north by Oregon, on the east by Nevada and Arizona, on the south by the Mexican Department of Lower California, and on the west by the Pacific Ocean, on which it has a coast line 1,097 miles in length. Measured along its greatest longitudinal axis, which bears nearly northwest and southeast, the State is a little over 700 miles long, and, having an average width of nearly 200 miles, its area approximates 156,000 square miles—in round numbers, 100,000,000 acres of land. Of this land, about 36,000,000 acres may be said to be, in its natural state, well adapted to agricultural pursuits of almost every kind, nearly all of it being equally well suited for stock raising; 30,000,000 acres, producing a variety of nutritious native grasses, constitute good grazing, and for the most part, also, good fruit-growing lands, though little fitted for farming purposes; 20,000,000 acres are mountainous and of not much value for farming or grazing, though nearly the whole of it is heavily timbered; 5,000,000 acres are composed of tule fens and overflowed lands, capable of easy reclamation, and which, possessing a deep, rich soil, must ultimately become exceedingly productive; the balance—5,000,000 acres—consists of alkali flats, lava beds, and sage plains, too saline, arid, and barren to ever be worth much for agriculture, though some portions of them may answer for sheep and cattle ranges.

TOPOGRAPHY—SYSTEM OF MOUNTAINS.

The principal mountains of California consist of the Sierra Nevada, the Inyo, and the Coast Range; the latter, which is made up of a series of parallel ridges and outlying spurs, extending along the western border of the State throughout nearly its entire length. The Sierra Nevada, on the other hand, stretches along the eastern border of the State for at least two thirds of its length, the Inyo Mountains lying beyond and running parallel with a part of the Sierra. In both the northern and southern portions of California occur various cross ranges and groups of mountains, together with numerous isolated peaks, buttes, and clusters of rugged hills; some of which are connected with, while others are wholly separated from, the dominating mountain chains. To the most of these lateral spurs, ridges, and outstanding groups distinct names have been given. Some portions of the Sierra Nevada are very lofty, Mount Whitney, the most elevated peak in the chain, being over 15,000 feet high, and, with two or three exceptions, the highest land in North America. There are several other peaks here that reach an altitude of 14,000 feet, there being many in the Sierra with some also in the Inyo range that vary from 10,000 to 12,000 feet in height. A number of peaks and ridges in the Coast Range approximate a height of 8,000 feet. The lower slopes of the main mountain ranges having been eroded by the swift descending streams into long ridges, undulating prairies, and lawn-like dells, are known as the foothill regions of the State.

THE VALLEYS OF CALIFORNIA

Are numerous and occur under widely varied conditions. Some are small and cradled far up in the mountains; some are larger and inclosed by hills of gentle acclivity, while others are of great extent, expanding into vast plains, little elevated above tide water, the immense depression lying between the Coast Range and the Sierra Nevada, four hundred miles long and fifty miles wide, the southern half known as the San Joaquin and the northern as the Sacramento Valley, furnishing the best example of these valley-like plains to be found in the State. The valleys of California are all fertile, and, while the smaller ones are for the most part tolerably well watered and timbered, the larger are apt to be deficient in this respect. But as tree culture is beginning to be practiced everywhere and water can be supplied to the most of these valleys by artesian boring or be brought in from the neighboring mountains, the above defects will in course of time be measurably remedied.

HYDROGRAPHY.

About one and a half million acres of California territory are covered with lakes, bays, and navigable rivers, the Bay of San Francisco constituting the largest body of water in the State. Besides this California contains only two other wholly land-locked bays—Humboldt and San Diego. Tahoe, one third of which lies in Nevada, is the largest and deepest lake in California, being 21 miles long, 12 wide, and 1,600 feet deep. It lies at an altitude of 6,000 feet, is fed by numerous streams from the adjacent mountains, and through the Truckee River discharges an immense quantity of water. The other considerable lakes in the State are Tulare, Mono, Clear, Klamath, Goose, Wright, Modoc, and Owens. Besides these there are many small deep lakes in the Sierra Nevada, and to the east of that range others so extremely shallow that some of them dry up in the Summer, for which reason they are usually called "mud lakes." Mono, Owens, and some other of these California lakes are so saturated with the carbonate and sulphate of soda, the chloride of sodium, borax, etc., that bathers float readily on the surface of their waters. Some, like Tulare and Honey Lake, cover a large area in the Spring and early Summer, when the snow melts on the mountains, but shrink to comparatively small dimensions later in the season.

The principal rivers of California are the Klamath and Trinity in the northern part of the State, and the Sacramento and the San Joaquin, formed by a great number of tributaries having their sources in the Sierra Nevada, and some of which are themselves streams of large size. These two rivers, flowing the one south and the other north, meet in the middle of the great basin to which they give drainage, and making a deflection to the west, debouch through the Golden Gate into the Pacific Ocean. The southern third of California contains no lakes or large rivers or even streams that in most countries would be called rivers at all, none of them being navigable, while many nearly or wholly dry up during the Summer season.

THE FORESTS AND PARTIALLY WOODED LANDS.

While some parts of California are well timbered others are but sparsely wooded or entirely treeless. The Sierra Nevada to a height of eight thousand feet, as also its higher foothills and some portions of the Coast Range are clothed with magnificent forests of pine, fir, spruce, and cedar; much oak up to four or five thousand feet growing in these forests. The higher foothills of the Sierra Nevada constitute the habitat of the so called "Big Trees," *Sequoia gigantea*, some of which measure at the base over one hundred feet in circumference, and three hundred and fifty feet in height. Being a species of cedar, these trees make a superior article of lumber.

Along the northern coast occurs a belt one hundred miles long, and from ten to fifteen wide, covered with a heavy growth of redwood. These trees, also a species of cedar, reach gigantic dimensions, some of them yielding from 30,000 to 40,000 feet of lumber. The foothills, up to a height of about two thousand feet, are covered with a scattered growth of oak and scrubby pine that burn well when dry, but are worth little for lumber. These oaks generally extend in the form of scattered groves down into the valleys, being about the only trees found there. The most of the larger valleys are in fact but sparsely wooded, what few trees they contain growing along the margins of the watercourses. These valley oaks often attain large proportions, single trees when cut up making as much as thirty or forty cords of firewood. They do not, however, grow to a great height, but have a short thick trunk which throws out many large branches, one of these trees sometimes shading nearly an acre of land. On the sage plains and deserts in the southeastern part of the State grow a few yuca palms and some mesquit trees, the latter a solid heavy wood, and excellent fuel, but the former useless alike for fuel or lumber. The alkali flats, lava beds, and tule lands are without timber. Taken as a whole, California may be considered a well wooded country, her coniferous forests covering some twenty millions acres, constituting, beyond any question, the most valuable timber lands in the world. With these mighty preserves, which when cut away rapidly reproduce themselves, and the much tree culture now going on, nothing but the most criminal waste can ever produce anything like a timber dearth in this State.

SCENERY.

What with her long and lofty ranges of mountains, majestic forests, and park-like hills; her picturesque valleys, deep gorges, and wide, extended plains, the scenery of California may be pronounced unique, grand, and beautiful in the extreme. The towering peaks of the Sierra and the softly rounded domes of the Coast Range arrest the attention, conspicuous from afar, while from many an eminence the great trunk rivers can be seen meandering for hundreds of miles through wheat fields and tule savannas, fed by innumerable streams that tumble in cataracts down the woody slopes of the mountains. Everything here has been projected on a scale well befitting this "Garden of the Gods." The waters of the Pacific lave the State on one side, while the snow-clad heights of the Eastern Cordillera look down upon it from the other. The gates of the Yosemite open into chasms as deep and precipitous as any found elsewhere in the world. Up from the champaign spring pinnacled buttes and crested ranges with chimney-formed rocks, tall and impending, while here and there a volcanic cone stands dark and lonely like a sphinx on the desert, for even these fields of desolation, over which "the mirage dances and the sand-storm sweeps," possess something to charm the lover of solitude as well as to interest the student of nature. How hardly can we find in other countries anything more satisfying to the artist, the tourist, or the scientist, than is to be seen here within the limits of California. The Alps and the Andes enjoy a well deserved fame for the grandeur of their scenery, while the views along the Rhine and the Hudson amount to an enchantment. But California, if she fails to combine all that is best in these, possesses in her scenery so much that is diversified, original, and vast, that it cannot fail to fill the appreciative mind with both admiration and wonder.

CLIMATE.

The most notable thing about the climate of California is its division into a wet season and a dry, the former extending from about the middle of November till the end of April, though it often begins a little earlier and continues for several weeks later. During this season there are generally from twenty-five to forty entirely rainy days, which occur at intervals of two or three, hardly ever of more than four or five, in succession. December and January are apt to be the wettest months, the rain for the rest of the time falling in showers with occasionally an entirely wet day. Very little rain falls during the dry season, sometimes not even a shower from one end of it to the other. The injury caused by such protracted drought is not so great as would at first be supposed, for, while the grass withers and the streams dry up, and the dust accumulates to a fearful extent, these evils are offset by many advantages. The roads though dusty are free from mud; outdoor work goes on without interruption; the farmer may cut his grain at his leisure, as it takes little harm from standing for a week or two after being ripe. Neither the hay nor the grain after being cut is apt to be injured by rain. Having been stacked, or gathered into heaps, the grain can be left to be thrashed, and the hay to be pressed and housed at any time before the wet weather comes on. So, also, the viticulturist may leave his grapes on the vines, and the orchardist his fruits on the trees, long after they are ripe, gathering them when it best suits their convenience. While the grass so dries up and fails to renew itself before the next rainy season, it does not lose its nutritious properties, cattle thriving upon it almost as well as when it is green. Rain occurring during the dry season causes only harm, as it bleaches the substance from the grass after it has been converted into hay, and no one being prepared for it, works much injury besides.

Except on the mountains and higher foothills but little snow falls, nor does much ice ever form in any part of California. The climate along the coast, and for 20 or 30 miles inland, is mild and equable, no extremes of heat or cold being ever felt here. Further inland the Summers are hot and the Winters somewhat colder than along this coast belt. Yet, in all the valleys of California, except the more elevated, apples remain on the trees and vegetables in the ground without freezing, while flowers bloom the whole Winter long. Stock, with the exception of milch cows and work cattle, receive little or no fodder, nor are any but work horses housed during the Winter. There are many localities in the southern part of the State that have over three hundred entirely clear days in the course of the year.

As the climate of California is so genial and temperate, so is it little liable to destructive tempests, violent electrical disturbances, or dangerous meteorological phenomena of any kind. From the cyclones and blizzards that have of late proved so disastrous to life and property in the Eastern States, California is wholly exempt, while the number of deaths from sunstroke and lightning does not exceed a dozen, all told. By the earthquakes, concerning which so much has been said to her disparagement, not over a score of lives have been lost since the American occupation of the country—scarcely more than one on an average every two years. The people of this State know nothing of famines, and little of floods, destructive inundations and damaging droughts being of rare occurrence here. Another good point about the climate of California is its extreme healthfulness. In few other countries is the death rate so small. Endemic diseases can hardly be said to exist here, while those of an epidemic kind generally prove to be of a mild type, being not often attended with fatal results.

POPULATION, WAGES, COST OF LIVING, ETC.

California contains now about one million inhabitants, of whom nearly one hundred thousand are Chinamen. Of these people about thirty thousand reside in San Francisco, where the most of them are employed as domestics, or engaged in washing and manufacturing cigars, clothing, boots, shoes, slippers, etc. Half as many, perhaps, live in the interior cities and towns of the State, where they are in like manner employed. Fifteen thousand work in the placer mines, chiefly on their own account. Several thousand carry on gardening, mostly in the vicinity of the larger towns. A few are fishermen, while a great many are employed in the canneries, at railroad building, in the reclamation of the tule lands, and in picking fruit, grapes, berries, etc., there being but few industries in the State but what employ some of these people.

While the prices of labor in California have been steadily declining ever since the memorable year of '49, the presence of the Chinese in the State has tended to precipitate the wages of the working classes in advance of all other prices, the rates paid for most kinds of labor being now not much higher in this than in the Eastern States. The difference in favor of California, except in the case of some skilled branches, will not average more than twenty per cent. Ordinary farm hands, for example, receive not over $20 per month and found, the year through. Wages during the harvest season range from $35 to $40 per month, or $2 per day and found. In the cities common laborers receive from $1 75 to $2 per day, finding themselves. In the machine shops, foundries, and similar works, daily wages vary from $2 25 to $3, these being about the rates paid in all manufacturing establishments, and about what mechanics, miners, engineers, teamsters, etc., are able to earn in California. Good axmen and sawyers are in demand in the lumber regions at extra high wages. In the canneries, cigar factories, and other establishments where women, girls, and boys can be employed to advantage, the average earnings are not over $1 per day, the usual length of a day's work in California being ten hours.

Although industrially so young, California has made good progress in many lines of production, outranking all the other States in the matter of gold, wine, wool, quicksilver, and barley; while in her wealth of neat cattle and her product of wheat, silver, and silk, she occupies the fifth place. She has also a greater length of telegraph lines and railroads, in proportion to population, than any of the older settled States of the Union, the railroads completed within her borders measuring over 2,300 miles, besides several short lines in course of construction.

The total value of the annual products of California amounts now to $170,000,000. The people of the State have on deposit, in the savings and other banks, $60,000,000. The assessed value of the real estate in California exceeds $500,000,000; the value of personal property approximating $200,000,000.

Taken as a whole, the staple articles of subsistence are not much dearer here than in the Atlantic States. Rents, fuel, water and lights, milk, eggs, butter and cheese, with some other items of prime necessity, are from twenty to fifty per cent higher here than there; flour, fish, fresh meat, fruits and vegetables, furniture, common clothing, boots and shoes, about the same. Considering how little fuel and extra warm clothing are required in California, and how comparatively few days need be lost by reason of sickness or bad weather, the laboring man can afford to live better here, and be able at the same time to lay up more money in the course of the year, than he could do in any other country.

COMMERCIAL PROGRESS.

As the domestic industries and the other material interests of California have prospered and expanded, so also has the commerce of the country grown into large proportions. With an import trade second only to that of New York, San Francisco has such virgin fields to occupy as open not to her great eastern rival. To her the trade of Australia and the Orient, including Eastern Siberia and the islands of the Pacific, geographically as well as commercially belongs, time, freights, interest, and insurance all being in her favor as against every other port in the world.

Although the trade of San Francisco, which may be said to represent largely that of the State, has suffered in some of its departments through the construction of two additional transcontinental railroads, the one to the north and the other to the south of the more central route, it still continues large, and has even increased in the aggregate since the completion of these lateral lines, indicating that this trade is not likely to be seriously crippled by these or other interfering causes. The value of the merchandise and treasure shipped from San Francisco in 1883 amounted to $105,000,000, of which $16,000,000 were consigned to foreign countries. Of these exports $60,000,000 went by sea and $45,000,000 by rail. The imports from foreign countries amounted meantime to $40,000,000, the following staples among other leading articles having been imported in the amounts here mentioned: sugar, 133,914,154 pounds; rice, 58,315,750 pounds;

tea, 20,960,248 pounds, and coffee, 17,444,777 pounds. The receipts of lumber at this port amounted for the year to 276,772,469 feet, valued at $5,000,000; receipts of Federal revenue, $12,558,305.

AGRICULTURE.

It is only about thirty years since the inhabitants of this State began to turn their attention to agricultural pursuits, the most of the manufacturing and mechanical industries that have thus far obtained foothold here not dating back so far, many of them in fact being of recent origin. For the first twenty years after the settlement of the country the principal occupation of our people was gold mining, and not until the surface placers became measurably exhausted did they begin largely to engage in other employments.

THE CEREAL CROPS.

All the grains cultivated elsewhere in the United States are successfully grown in California, and in quantities in the order here mentioned: wheat, barley, oats, corn, rye, buckwheat. There are millions of acres in the State well suited for the cultivation of rice, but none of this grain has been produced, as it can be imported much more cheaply than it could be raised here. The following figures represent about the average annual crop of the above cereals produced in the State during the past five years, the quantities being expressed in bushels, with market value of each attached: Wheat, 45,000,000, value, $50,000,000; barley, 10,000,000, value, $7,000,000; oats, 3,000,000, value, $2,000,000; corn, 3,000,000, value, $2,000,000; rye, 300,000, value, $200,000; buckwheat, 5,000, value, $5,000. These grains commanding in San Francisco within ten per cent the prices current in Atlantic seaports. No grain except wheat, with occasionally a little barley, is exported from the State. The annual shipments of wheat and flour from San Francisco amount to about 1,250,000 tons, of the aggregate value of nearly $40,000,000. A million and a quarter barrels of flour are made from the wheat crop every year, by the 200 flouring mills in the State—120 driven by steam and 80 by water-power. The yield of the cereal crops is from twenty to thirty per cent higher in California than in countries east of the Mississippi River; such a thing as a general failure of these crops having never occurred in the State. Wheat occasionally suffers from rust in the coast counties; it is, also, in districts further inland, sometimes blighted by a hot north wind that blows while the berry is in the milk. The crop is, moreover, frequently shortened by drought, this occurring most often in the great interior valleys.

Unimproved agricultural land in California is cheap, there being much of tolerable good quality still open to preëmption and homestead location. It can also frequently be bought with some improvements on at moderate rates. The Central Pacific and the Southern Pacific Railroad Companies have much good land which they offer for sale at prices ranging from $2 50 to $5 per acre, selling on time if purchasers desire it. While the above class of lands can be obtained at such reasonable figures, highly improved lands, eligibly situated as regards markets, are rather dear—very large prices being asked for properties of this kind when planted with choice fruit trees and vines.

WHEAT.

The crop of this cereal reached in 1883, 43,000,000 bushels, valued at $42,500,000. This is somewhat below the usual product of the State, the crop of 1880 having exceeded 50,000,000 bushels. The State Agricultural Society, in their report issued about the middle of April, while admitting that it was then too soon to figure with much certainty, estimated the wheat crop for 1884 at 48,000,000 bushels. It has since turned out to be over 50,000,000. The wheat fields of California yielded at first an average of twenty-five bushels per acre; but as planting has been extended to lighter soils, and the soil everywhere, through continuous cropping, has tended to deterioration, the yield does not now average over fifteen bushels to the acre—much above the yield in the older States of the Union. Our wheat is apt to be heavy, the most of it weighing sixty and some of it as much as sixty-four pounds to the bushel. Occasionally, however, the berry in some of the large interior valleys is light, being shriveled by a hot north wind that blows while it is in the milk. The flour exports of 1883 were 1,254,519 barrels, valued at $6,158,416. Of late years we have been making more of our wheat into flour than formerly, as by this plan there is effected some saving in freights, California flour being noted for its keeping properties on long sea voyages. China was at one time our best flour customer, but for the past year or two our millers have been shipping more of this article to Great Britain, which becomes now our largest consumer of both flour and wheat. The purchasers of our flour rank in the order here mentioned: the United Kingdom, China, Central America, Australia, Hawaiian Islands, and Panama.

BARLEY.

About 19,000,000 bushels of barley were raised here in 1883, valued at $10,000,000, this being the largest crop ever grown in the State. Much of our barley is ground for horse feed, more, however, goes to the brewers. Our exports last year were 229,168 centals, nearly all to England and the Eastern States; a little also to British Columbia. Barley is a tolerably sure crop in California, the plant not being liable to suffer from rust, insect pests, or the blighting north winds, which sometimes prove so injurious to the wheat while the berry is filling. When this grain is stinted by drought, or grows so rank that it is not likely to fill, it is frequently cut for hay before being quite ripe.

OATS.

Our average crop of oats approximates 3,000,000 bushels, nearly all of which is used for horse feed, a little being ground into meal. Our exports of this grain are small, though we receive a good deal every year from Oregon—price in San Francisco about one and a half cents per pound. The crop with us is a tolerably sure one and the yield about twenty-five bushels per acre.

INDIAN CORN.

Raised in 1883—3,250,000 bushels, the leading corn counties being Los Angeles, with 1,300,000 bushels, and Sonoma, with 1,145,000 bushels. The climate of California, by reason of the cool nights that prevail in the Summer, is unfavorable to the growth of this cereal. A good deal of the corn raised here is of the kind suited for table use, or for canning while green. We do not feed much of this grain to swine, as is practiced in the East, most of it being ground into meal, in which shape some of it is made into bread and some fed to neat cattle. Of late, importations have been considerable—a little, as always, coming from Mexico, but more from Nebraska.

RYE.

Average annual product, 300,000 bushels, San Joaquin County, the largest producer, being credited with a third of the whole. The crop is all consumed at home, mostly for making bread.

BUCKWHEAT.

Five thousand bushels are produced annually; 1,500 in Los Angeles County. As with rye, it is all ground into flour and required for domestic consumption.

HAY.

Compared with the number of domestic animals kept in the State, but little hay is made in California. Receipts last year at San Francisco, 81,472 tons, which represent, perhaps, one fifth of the quantity cured in the State. Price in the city, $12 to $18 per ton, as per quality; delivered on or near the field, about half these rates. Formerly nearly all our hay was made from the wild oats and indigenous grasses; now a good deal is the product of the cultivated grasses, alfalfa chiefly, or of wheat, barley, and oats, cut while green. Millet is being grown to some extent, with a good prospect that it will be found a valuable grass both for dry forage and pasturage. With improved breeds of cattle, we feed more hay now than when the country was overrun with wild Spanish herds, which never received housing or fodder of any kind.

VEGETABLES.

Almost every kind of vegetable can be grown in California, in many localities without, and in nearly all parts of the State with, the aid of irrigation. Under favorable conditions they are apt to grow luxuriantly, some of the vegetables raised here having been noted for their large size. Thus, we have produced squashes of good quality weighing 260 pounds each, a weight of 800 pounds having been grown on a single vine. We have grown cabbages weighing over 50, beets, 118, and watermelons that weighed 65 pounds each, with carrots, turnips, and other vegetables of corresponding size. These dimensions are, of course, exceptional; yet with a good soil and sufficient moisture the vegetables raised here generally exceed those grown in most other countries, both as regards size and weight. Of ordinary vegetables there were raised last year the following quantities: potatoes, common, 350,000 tons; sweet, 3,400 tons, over one half of which were grown in Los Angeles County. While the former kind can be raised almost anywhere in California, San Joaquin, Sonoma, San Mateo, Los Angeles, and Mendocino may be accounted the principal potato-growing counties of the State. Our only foreign customers for this esculent are the Chinese and the Sandwich Islanders, the former taking a good many every year. Our onion crop averages 400,000 bushels, Alameda and Los Angeles being preëminently our onion-producing counties, the former turning out about 60,000 and the latter about 55,000 bushels annually. Beans, 375,000 bushels—forty per cent of the whole raised in Santa Barbara County. Castor beans, 1,200,000 pounds, all the product of 900 acres in Los Angeles County. Peas, 65,000 bushels; Humboldt, the banner county, 43,000 bushels. This estimate does not include green peas, of which many are consumed in the State. Of pumpkins, squashes, melons, and vegetables of nearly every other kind, we raise such quantities that they are in their season supplied to the markets at very low prices. There are few articles in this line but what can be found fresh in the San Francisco market the year round.

FRUIT RAISING, CURING, AND CANNING.

The number of fruit trees in California of the kinds mentioned below is estimated at 8,000,000, subdivided as follows: apple trees, 2,700,000; peach, 1,200,000; pear, 500,000; plum and prune, 600,000; cherry, 400,000; apricot, 500,000; orange, 1,600,000; limes and lemons, 500,000; besides which there are several hundred thousand fig, olive, quince, and various other fruit-bearing trees, not to mention a vast number of currant and berry bushes of every description. As this class of trees are apt to be prolific bearers, the fruit crop of California is always large, so large that much of it in remote localities is left every year to perish ungathered. Vast quantities of it are, however, preserved by drying or by bottling and canning, this business having reached large dimensions and proved both safe and profitable.

Fruits of almost every description can be grown all over California up to an altitude of 2,500 or 3,000 feet, apples, pears, plums, etc., maturing in the mountain valleys at elevations of 5,000 feet.

DRIED AND CANNED FRUITS.

Curing fruits by the process of desiccation is done either by sun or artificial drying, the later being effected by machines or ovens heated for the purpose, and many of which are coming into use in California. Our dried fruit amounts to about 3,000,000 pounds annually, the most of it consisting of apples, peaches, pears, prunes, figs, and plums, nearly one third of the whole being cured by machine drying. These fruits are in request in the eastern markets, to which a good deal is sent every year. Some is also sent to different parts of the Pacific Coast, and a little to other countries.

At the fruit and vegetable canneries, twenty-five in number, scattered over nearly all parts of the State, there were put up last year a total of 1,025,000 cases. Of these 750,000 cases consisted of fruits and berries, and 275,000 of vegetables, the whole having a market value of $4,500,000. These establishments have capacity to put up from 2,500 to 200,000 cases every year, the number of persons employed in them varying from twenty-five or thirty to fifteen hundred. Of the products of these canneries we export seventy-five per cent, the balance being consumed at home. These goods, like our dried fruits and canned salmon, are sent to many different countries, England, the Eastern States, and the Territories west of the Rocky Mountains taking the major portion of them. Some are sent, also, to British Columbia, Mexico, Central and South America, the Sandwich Islands, Australia, China, Japan, etc. Of our early fruits large quantities, also grapes, are shipped in their green state to Chicago and other eastern cities. The cost of putting up fruits in this manner amounts to $1 75 per case of twelve cans. Our importations in the line of canned goods consist mainly of oysters, condensed milk, chicken, turkey, pineapples, meats, and some few fruits and vegetables that we do not produce in full supply, or which may be required to replenish exhausted stocks. Imports of these latter are diminishing every year.

Although a great deal of the fruit grown in this State is disposed of while green, the most of it is preserved either in hermetically sealed vessels or by the process of drying. Of the earlier varieties much is shipped east by rail, also large quantities of grapes, berries, etc., the total amount so disposed of averaging about 15,000,000 pounds annually. We also supply our more immediate neighbors largely with these articles. Some green apples are sent as far off as the Hawaiian Islands and Australia.

DOMESTIC ANIMALS.

Of horned cattle, California contains now about 800,000 head, not a third of the number in the State thirty years ago. But the cattle now on hand are largely of improved breeds; a considerable proportion being kept for dairying purposes; whereas formerly the entire number consisted of Spanish cattle, raw-boned and half wild, raised only for their hides and tallow. While they are pretty well distributed over the State, the central and southern counties have a preponderance of the neat cattle.

Of horses and mules, California numbers about 300,000 of the former and 28,000 of the latter. The horses consist of pure-blood animals, wild Spanish stock, and a cross between the two. Many of the mules are also of improved breeds.

We have at present something over 5,000,000 sheep in this State, from which there were clipped last year 40,848,690 pounds of wool, valued at $8,000,000. With us these animals commence to breed early and multiply rapidly, the annual increase averaging about fifty per cent. With nearly all who have engaged in it, sheep raising has proved a profitable business. Of our wool clip, 7,000,000 pounds are manufactured into goods of various kinds, mostly cloths and blankets of the finer varieties, the rest being shipped to eastern markets.

We have probably 20,000 Angora or Cashmere goats in the State, the present stock being largely crossed with the common varieties. Being unacquainted with the business, our first trials with these animals have been disappointing. As we have much land well adapted to the wants and habits of these goats, and as their fleeces are in demand, there is little doubt but there will yet be large numbers of them raised in California. Some of the flocks have already proved profitable.

SWINE.

We have about 400,000 of these animals in the State, less by one half than we had twenty-five years ago, when, breeding without much care, thousands of them ran wild in the tule lands, and their range was generally less restricted than at present. Our annual slaughter of hogs averages about 250,000, their product last year being: ham, 4,850,000 pounds; bacon, 5,325,C00; lard, 2,880,000, of the estimated value of $2,000,000. Of these articles, we import from States east of the Rocky Mountains largely every year. As with increased irrigation there will be grown more of the succulent grasses and roots necessary for the sustenance of swine, it may be expected that a larger number of these animals will be raised in California hereafter, enabling us to become more nearly self-sustaining in this line of products. The hog does not thrive in the agricultural districts of the State, as these afford but little mast and not enough Summer moisture for his comfort.

POULTRY.

Domestic fowls, as a general thing, do well in California, where a great many of one kind and another are kept. In some of the coast counties chickens are subject to diseases which in many cases prove fatal. The increased value of the poultry last year is estimated at $100,000. Eggs being largely consumed here, many are imported from the Western States, also some from Utah. Both eggs and poultry are considerably dearer here than in the Eastern States.

DAIRIES AND THEIR PRODUCTS.

The business of dairying is carried on extensively in California, the annual product of butter having for a number of years past averaged about 11,000,000 pounds; cheese, 4,000,000; about four tenths of the butter having been made in Marin, and one eighth in San Luis Obispo County. At certain seasons of the year we ship butter to the East, receiving at others a little butter with some cheese from choice dairies in return. Our imports of cheese come, however, mostly from Switzerland. We supply butter to British Columbia, the Sandwich Islands, and other of our neighbors. Many California dairymen keep large numbers of cows. Messrs. Howard & Shafter had at one time on their ranch in Marin County as many as 3,500 head, divided up into seventeen dairies. The Steele Brothers of San Luis Obispo County, keep from 600 to 800 head, and there are probably a hundred dairies in the State that have from 50 to 100 head each. Our milch cows are either of the pure English breeds, American animals, or a cross of these, mixed sometimes slightly with the lank, long horned Spanish stock, which are poor milkers.

VITICULTURE.

GRAPES, WINES, AND RAISINS.

If there is one thing in the vegetable domain for which the soil and climate of California are better adapted than any other, it is their fitness for growing the grape. Nearly the whole State below an altitude of three or four thousand feet, may be said to consist of tolerably good, the most of it first class, vine lands. We have probably more land of this kind within our borders than France and Italy combined. While so nearly the whole of California may be considered the habitat of the vine, the territory best suited for its culture is comprised in a belt reaching laterally from the western slopes of the Coast Range to the higher foothills of the Sierra Nevada, and extending the entire length of the State, a distance of nearly 700 miles. The cultivated grape has been grown successfully in California for a long time, the first plantings having been done by the Catholic Fathers more than a hundred years ago. The vine set out by them, though hardy and a good bearer, yields rather a common sort of fruit, known here as the Mission or Los Angeles grape. For several years at first our modern plantings were mostly composed of this grape. Of late, however, it is being superseded by better and generally very choice varieties.

Charles A. Wetmore, an authority in all that relates to viticulture in California, estimates that we have now 160,000 acres planted to vines, such estimate including 30,000 acres set out the present year. Calculating 800 vines to the acre—about the average—gives 128,000,000 vines now in the ground, of which a third are in full or partial bearing. Mr. Wetmore is of the opinion that we shall have in another year as large an area as 70,000 acres of vines five years old and upwards, and that such area will in the course of four years more be enlarged to nearly half a million acres, containing over 400,000,000 bearing vines.

Our vintage of late years has been as follows: 1881, 12,000,000 gallons; 1882, 9,000,000; 1883, 9,500,000. Calculated on this basis, the product of our vineyards for the near future may be estimated as follows: 1884, 12,000,000 gallons, with possibilities of 14,000,000; 1885, 15,000,000; 1886, 20,000,000; 1887, 25,000,000; 1888, 33,000,000 gallons. For a number of years past the value of the California wine product has averaged about $6,000,000 per annum, though last year, owing to a short grape crop, it amounted to only $5,000,000. Brandy from the grape, of which several hundred thousand gallons are made every year, is not included in the above estimates.

The more obvious defects of our California wines have been due to lack of skill and care in their manufacture, and to insufficient age. They have not, as a general thing, been wanting in inherent good properties, and the above causes of their defects are being every year diminished. They have this further to recommend them to wine drinkers everywhere: they are absolutely pure, our vintners practicing no adulteration whatever. It is true they have recourse sometimes to the subterfuge of selling their wines under foreign labels, this being a concession to the preferences of a certain class of consumers, who, having been accustomed to the use of foreign brands, the accommodating vintner, more often the retailer, takes this method for gratifying the tastes of his customers. With the considerable experience our people have had in the business of wine making, and the practice of storing for age every year extending, coupled with the fact that the later plantings have largely consisted of the better class of vines, there can be little doubt but the bulk of the wines turned out in this State will, in the course of a few years, be superior to those produced in any other part of the world.

The price of grapes per ton, delivered at the wineries, has, for the past five years, been as follows:

	Mission.	Foreign.
1879	$14@16	$18@26
1880	18@23	30@35
1881	20@22	28@35
1882	17@18	30@36
1883	18@25	25@35

Grapes of the kinds suitable for table use and raisin making command somewhat higher prices than the above. Of the vintage about twenty per cent is consumed for these and like purposes, eighty per cent going to the wine press.

The yield of our vineyards varies with seasons and other conditions, the average being from four to five tons per acre. Cuttings begin to bear here the second year after being set out, the vintage thence on increasing for a number of years. Not only is the vine with us a thrifty grower and early bearer, but it is apt to be long lived as well, there being examples of some set out nearly one hundred years ago still bearing abundantly.

The wine product of California is disposed of as follows: We consume at home about 4,000,000 gallons; export 3,000,000 gallons; retain for aging 3,000,000 gallons; 3,000,000 gallons of brandies and sweet wines being distilled from wines, sediments, and pressings. Our exportations of wine during the past ten years have been as follows:

	Gallons.
1874	1,000,000
1875	1,031,507
1876	1,115,045
1877	1,462,792
1878	1,812,159
1879	2,155,944
1880	2,487,353
1881	2,845,365
1882	2,916,775
1883	3,100,000

Exports of brandy meantime have been:

	Gallons.
1874	40,000
1875	42,318
1876	59,993
1877	138,992
1878	129,199
1879	163,892
1880	189,098
1881	209,677
1882	214,162
1883	220,500

Many of the vineyards of California are very extensive, numbering from 200,000 or 300,000 to 500,000 vines each. It is probable that this State can boast of the largest single grape plantation in the world, that of Governor Stanford, at Vina, in Tehama County, comprising 10,000 acres, 2,800 acres of which has been planted with vines mostly of choice varieties.

California offers all the conditions requisite to the production of a good and a cheap raisin. As with wine, the earlier attempts at raisin making failed to produce a perfect article. But lately such improvements have been made in the business that it may now be considered a complete success, many of the California cured raisins being nearly or quite equal to the best imported. The industry is bound to expand rapidly and reach ultimately large proportions. The curing of last year amounted to 130,000 boxes of 20 pounds each, which sold in the market at the average rate of $1 35 per box. The product last year was much less than may ordinarily be counted upon, the early rains having greatly injured the fruit and interfered with the process of curing.

STATISTICAL SUMMARY.

While we have in California a great variety of pursuits, interests, and improvements, each entitled to extended comment, only a few, even of the more important can, in a cursory review like that here contemplated, be noticed with much fullness. Reserving what relates to the more useful minerals and metals, and the industries and enterprises connected with their development, to be described more in detail further on, we give below an epitomized account of most of the leading industries of the State.

Summarizing, we present first the following

COMPREHENSIVE EXHIBIT,

As tending to illustrate in a general way the progress heretofore made, and the present financial, commercial, and industrial status of California: The State now contains 1,000,000 inhabitants, which number is being increased through births and immigration at the rate of 60,000 per year. With her available lands all occupied, and her natural resources fully developed, California would be capable of sustaining a population of 20,000,000. She has within her limits real estate of the assessed value of $500,000,000; personal property, $200,000,000; 9,000,000 acres of land inclosed; 7,000,000 under cultivation; value of annual products, $180,000,000. As a State she is practically without any debt. Deposits in savings banks, $60,000,000; banking capital of the State, $50,000,000; annual bullion product, $18,000,000; average value of wheat crop, $45,000,000; barley, $10,000,000; dairy products, $8,000,000; fruit crop, $7,500,000; wool, $8,000,000; wine, $5,000,000; value of lumber made in the State, $5,500,000; hay cut, $13,000,000; value of domestic animals of all kinds, $60,000,000; value of animals, poultry, etc., slaughtered every year, $23,000,000; increased value imparted to manufactures, etc., by labor, $40,000,000; number of grapevines set out, 130,000,000; fruit and nut trees, 800,000, with five times as many forest, shade, and ornamental trees. The State contains 3,500 miles of telegraph lines; 3,300 miles of railroad; 5,000 miles of mining, with an equal extent of irrigating, ditches; 400 quartz mills; 300 sawmills, and 185 flouring mills; $250,000,000 have been invested in mining improvements in the State, cost of quartz mills, tunnels, and ditches included.

VARIOUS AGRICULTURAL PRODUCTS AND MINOR PURSUITS.

We have in California a great many industries which, being of secondary importance or but remotely connected with the subject of mining, have here been roughly classified and disposed of in a summary way, since to enlarge upon them as their merits deserve would swell this paper to undue proportions. While our method of treating them amounts to hardly more than making a catalogue of these collateral and minor topics, we have felt that they should not, in a paper of this kind, be wholly overlooked. Proceeding then to deal with this class of subjects in the manner indicated, it may be observed that—

In the domain of agriculture, we have experimented widely and successfully; growing, maturing, and generally bringing to the highest perfection, all the products of the temperate, with many belonging to the semi-tropical, zones. We raise every important cereal known to agriculture; wheat and barley in great quantities. The orange, lime, and lemon have become staple fruits in California; and even the banana, heretofore deemed a purely tropical plant, has ripened its fruit in some parts of the State. If some of our trials with vegetable products have proved disappointing, this has, as a general thing, been due to the high prices of labor, lack of skill and care in their cultivation, or to the presence of other unfavorable conditions aside from soil and climate; and that we have met with a few disappointments in this respect must be admitted. Our experiments with coffee, tea, tobacco, sugar cane, sorghum, ramié, and cranberry growing have, for example, turned out but poorly, and in some cases for the reason that our climate is not suitable for the cultivation of these products, frosts having injured the ramie and coffee plants or killed them outright. In the matter of tea and tobacco, while the curing was no doubt faulty, the leaf of both was lacking in flavor. The cranberry failed because the site was injudiciously chosen and the soil badly prepared, there being plenty of land in California well adapted for the cultivation of this berry, and tobacco, as well. As regards ramié, there is a large extent of bottom lands on the Colorado River where it could be successfully grown, if nowhere else in the State. Not having as yet succeeded in supplying ourselves with the commodities here mentioned, we import the most of them; tea, from China and Japan; coffee, from Mexico, Costa Rica, Brazil, and other parts of the world; tobacco, from Cuba and the Eastern States; sugar, mainly from the Sandwich Islands; and cranberries, from certain of the Western States, also a wild fruit, in considerable quantities, from British Columbia.

The broomcorn we raise is made into brooms, wisps, brushes, etc., of which we send annually about 4,000 dozen to interior and coastwise markets, also some to the Sandwich Islands, Australia, and the Orient, retaining, perhaps, twice as many for our own use. Owing to the dryness of the climate, the California broom is hardly as tough as that grown in the East. We make most of our mustard, chiefly from the cultivated, partly from the wild, plant, which latter covered at one time the rich valley lands in many parts of the State with a growth so sturdy that it stubbornly resisted the efforts of the farmers at rooting it out, many plowings having been required to effect that end. The chicory we raise, though scarcely equal to the German, being cheaper, is making headway against the latter. Buhach, the plant from which the so called Persian powder is made for killing fleas and other insects, is grown quite extensively and profitably in Kern County—a little, also, elsewhere in the State. This powder has been found very effective for the destruction of insect pests of various kinds, and so much is it being employed for this purpose that the verb "to buhach" has come into common use among vine-growers and horticulturists in some parts of California. The guava plant is being cultivated in the neighborhood of San Diego with the prospect of its becoming very remunerative. Though highly esteemed for table use, most of this fruit is made into jelly.

IN THE DEPARTMENT OF WOODWORKING

We accomplish a great deal—make furniture in large quantities and of every kind, from the most elegant rosewood parlor set to the rawhide-bottomed chair, and this, notwithstanding few of our native woods are well suited for the purpose. Latterly this business has been a little depressed owing to the completion of the Northern Pacific Railroad, causing the eastern to compete sharply with our local manufacturers for the Oregon trade. The product of our shops is in nowise inferior to the best made elsewhere, suitable woods being largely imported, and the services of artisans trained in eastern and European factories having been secured in all our larger establishments. We dispose of but little home-made furniture except to our immediate neighbors. Our manufacturers are paying increased attention, not only to the selection and seasoning of their woods, but also to fashioning and finishing their wares, insuring to their customers articles of greater excellence than they were able to turn out at first. Besides furniture in such variety, we manufacture pianos, organs, and other musical instruments, picture and mirror frames, billiard tables, etc. The construction of wheeled vehicles is a great business in California, extending to every kind of conveyance, and being carried on throughout all parts of the State, and this despite heavy importations both by land and sea. Owing to the high wages paid workmen, labor-saving implements and machinery of all kinds have ever been in great request in California. Especially with the large grain raisers has this been the case, hence the heavy importation of gang plows, seed sowers, harrows, mowers and rakers, reapers, thrashers, separators, etc., and this notwithstanding we make at home great numbers of these articles, there being at least a dozen establishments in the State devoted to their manufacture. To San Francisco the north coast as far up as British Columbia, also, Mexico, Arizona, and the Sandwich Islands, look for their supplies in this line, either wholly or in part.

As much water requires to be raised during the long dry seasons that prevail in California, windmills in great numbers are availed of for this purpose. These machines, the most of which are made here, are of diverse patterns—some simple and cheap, costing not over $50, others large and complicated, costing as much as a thousand or fifteen hundred dollars—average cost, about $200. The windmill is employed here for raising water, not only for domestic, but also for irrigating and manufacturing purposes. We make now on this coast, mostly in San Francisco, about all the woodenware we require, and of which we consume annually values to the amount of $250,000. Some articles in this line, such as ax and pick handles, whip-stocks, chopping trays, etc., we obtain from the East, because we have not here suitable woods for making them. This deficiency will, however, be in good time supplied, as arboriculturists are taking pains to plant such trees as will furnish this much needed kind of lumber. Of willowware we make yearly about $12,000 worth, our imports amounting to four times as much. The business, which requires but little capital, is carried on by eight or ten different parties, each in a small way—some basket-making and rattan work being generally connected with it. All the raw material is imported, but as we have any amount of waste tule land suitable for growing the osier, economy suggests that we raise enough of it for our own use, which we will probably do before long. In a country so prolific of fruits and wines, boxes and casks must necessarily be in large demand; hence, the incredible number of these articles made up every year in California. Owing however to the cheapness of lumber, this package tax is not very onerous. While most of the cooperage business is done in San Francisco, there is still a good deal carried on throughout the wine growing districts of the State. Among the smaller articles made from wood, we manufacture faucets and bungs, lasts, matches, etc. Our matches are so cheap and so good, that we export every year about 5,000 cases of them, against only a few hundred imported, although the importation was at one time very large.

IN METALS, FROM THE MOST PRECIOUS TO THE MOST COMMON KINDS,

We have from pioneer times been great workers. Inhabiting a region so abounding in gold and silver, we naturally took to the manufacture of plate, jewelry, and other articles of ornamentation at an early day, and have since done much at the business, in which our artists have reached great proficiency. Of our achievements in working up iron something has been said in the articles pertaining to our foundries, machine shops, etc. But in addition to iron we have establishments that manufacture articles and wares from all the other useful metals, the number of hands employed in them amounting to at least 2,000—gross value of products, $5,000,000. With us the wages paid workers in metals rule high, about seventy-five per cent higher than prevailing rates in the Atlantic States. Our brass and bronze foundries use up copper, tin, zinc, lead, and antimony to the amount of 600 tons annually, and produce everything usually made at similar works elsewhere—products valued at $500,000. Our lead works, described more fully elsewhere, employ 150 hands, and turn out products to the value of $800,000 per annum. There are, probably, 150 tinshops in California, Chinese and repair shops counted in—value of products, including such sheet-iron wares as are usually made in connection with this business, $1,200,000; hands employed, 600, one fifth of them Chinese; capital invested, $575,000. Formerly our importations in this line were large; they now scarcely exceed $400,000 per year, consisting mostly of "pressed" wares. Our coppersmitheries, all but two or three located in San Francisco, employ 60 men, at $3 50 per day, and manufacture wares to the value of $250,000 annually. Gasfitting and plumbing, japanning, galvanizing iron, silver plating, gold beating, and gilding are all carried on here to a greater or less extent. We also manufacture some cutlery, firearms, mathematical, telegraphic, and electrical instruments, clocks, watches, etc. Of the tacks, nails, files, and other articles of hardware, made by the Judson Manufacturing Company, mention is made in our article on the works and products of that company. We have two stove factories, although as yet not much hollowware or other domestic utensils have been cast in the State. The value of our home-made stoves amounts to about $300,000 per year—imported, $1,000,000. We shall soon make about all the stoves required in California, and, probably, some for exportation.

While our soap and candle factories turn out large quantities of good articles in their respective lines, we continue making heavy shipments of tallow to the East, where it is made up into soap and candles, brought back and sold to us with cost of freights, manufacture, interest, and insurance added. Of turpentine we produced during war times all we wanted for our own use, but shipments being resumed, on the restoration of peace, prices so declined that the home manufacturer was obliged to abandon the business, being no longer able to compete with the imported article. As we have vast forests of terebinthine trees, there is little doubt but we will yet produce not only enough pitch, tar, and turpentine for our own use, but enough for our commercial neighbors.

Three Italian paste companies, operating in San Francisco, supply not only the wants of the coast, but also the export demand, now considerable, with macaroni and vermicelli, employing, of course, only California flour in their manufacture.

We have several cracker factories in the State, all the larger ones being located in San Francisco. The works of the California Cracker Company are said to have capacity equal to any in the United States. While we make some gutta percha and rubber goods, the bulk of such goods used here continues to be imported. We prepare cocoa for chocolate, of which the several factories in San Francisco turn out a good deal. We make both writing and printers' inks; varnish, to the amount of 60,000 gallons yearly; besides which, we import 20,000 gallons, all consumed at home. We make artificial limbs to the value of $10,000 or $12,000 per year; some smoking pipes, both wooden and meerschaum, but none of clay—about one fourth of the shoe blacking used in the country; 30,000 pairs of lasts, some of which are sold abroad. Two axle grease factories, both located in San Francisco, employing about a dozen hands, make annually 150 tons of this lubricant, valued at $45,000; besides this, we import from the Eastern States 50 tons. Our exports of axle grease, amounting to 25 tons, go mostly to Mexico, British Columbia, the Sandwich Islands, and Australia. A dozen mills, three fourths of them located in San Francisco, grind up spices, mustard, chicory, etc., to the value of $2,000,000 per year. Our imports of pepper, nutmeg, cloves, cassia, and allspice, amounted in 1883 to 1,049,850 pounds, double the quantity imported any previous year. The only safes made on the coast are manufactured in San Francisco, by Jonathan Kittredge, on orders for articles of great size or of patterns not made for the trade. We import all others; also, nearly all the locks, keys, etc., required on the coast. An attempt was made to establish a lock factory here some years ago, but it did not succeed. Chains of extra large size we make; smaller and poorer ones are imported. Mattress springs are manufactured in San Francisco. Seventy-five per cent of our wagon and carriage springs are brought from the Atlantic States at an annual cost of about $260,000. Four foundries, employing 45 hands, make $50,000 worth of type every year; besides which, we expend about an equal amount for imported printers' material of various kinds. We make a few rubber and gutta percha goods, importing of these articles to the extent of $1,000,000 worth annually. We have mills that clean rice, grind salt, plaster, etc. We manufacture trunks, carpet sacks, satchels, etc., to the value of $350,000 per year, this branch of business giving employment to 200 operatives. We make annually 4,700 barrels of glue, of the aggregate value of $85,000. The most of this article we export, three fourths of it to New York. The single surviving starch factory of several that have been started in California, turns out annually 100 tons of this commodity, valued at $16,000. Our imports, mostly from the Eastern States, amount to 1,200 tons; exports, 80 tons, our principal customers being Mexico, British Columbia, the Sandwich Islands, and China. The manufacture of clothing of every description; straw, felt, and silk hats; gloves, slippers, and regalia; parasols and umbrellas; neckties, suspenders, and an infinite variety of similar small articles, is carried on very extensively in San Francisco, though it is greatly to be regretted that so large a proportion of these employments, which ought to be reserved for the women and the youth of both sexes, is here engrossed by the Chinese.

MANUFACTURING, MECHANICAL, AND OTHER LEADING INDUSTRIES OF THE STATE.

GUNPOWDER AND OTHER EXPLOSIVES.

We manufacture in California the various explosives, high and low, to the value of about $2,000,000 annually. We also import from the Eastern States considerable powder, both sporting and blasting, though the quantity is being gradually diminished. Our exports are chiefly to Mexico and British Columbia, with a little to the Hawaiian and other of the Pacific Islands, and amount to about 800,000 pounds per year, valued at $133,000. During the past year the home consumption, owing to some abatement of railroad building and hydraulic mining, has been less than usual. The capital invested in powder making, all the various kinds included, amounts, probably, to $3,000,000; number of hands employed, 300, many of them Chinamen; wages paid vary from $1 25 to $3 50 per day. Of the crude stock, the acids, charcoal, and part of the glycerine, are made in the State. The nitrate of potash is imported from Calcutta, and the nitrate of soda from Peru, the sulphur being obtained mostly from Sicily and Japan, with a little sometimes from the State of Nevada.

The California Powder Works—Located near the town of Santa Cruz—constitute the only establishment in California at which the various kinds of common or black powder are made. These works, which give employment to about 50 hands, all whites, are very extensive, comprising 21 powder mills, 10 shops, 6 magazines and stores, besides 35 other buildings. In their equipments they are very complete, embracing all the machinery and processes pertaining to the manufacture and putting up of gunpowder, from the distillation of wood for charcoal and the refining of niter to the final packing in wooden and iron kegs, all of which are made on the premises. The powder produced at these works includes both the fine and coarse varieties, such as sporting, blasting, etc., some of it being especially adapted for subterranean and submarine blasting. It enjoys an excellent reputation, having been able to nearly monopolize the trade since the company was organized, more than twenty years ago.

The same company have put up works at Pinole Point, on the shore of San Pablo Bay, in Contra Costa County, for the manufacture of Hercules powder, a business prosecuted here on quite an extensive scale. This, like their powder works near Santa Cruz, is a very comprehensive establishment, comprising large factories for making sulphuric and nitric acids. The Hercules powder from Pinole Point has come into general use on this coast, having commended itself to consumers both for its strength and safety.

Besides the foregoing we have several other companies engaged in making the high explosives in California, such as the Giant, Vulcan, Safety-Nitro, Vigorite, etc. Owing to the diminished requirements, these companies, finding they were making such an over production as prevented their realizing any profits, agreed among themselves in May last to so restrict the output of their works that some advance in prices would be possible. Although no higher rates for powder have yet obtained, this may soon be looked for, as a new schedule of prices has been agreed upon.

Fireworks.—We burn on the coast fireworks to the value of $80,000 annually, the consumption of these articles being less now than formerly, by reason of municipal ordinances restricting their use in the larger cities. Three factories in San Francisco, employing 15 hands, make the fixed or larger pieces, the smaller, such as crackers, rockets, etc., being brought from China. The import trade is mostly in the hands of the Chinese, with us the principal consumers of this style of combustible. We supply firecrackers to the surrounding countries and send a few to Mexico and South America.

Blasting Fuse.—We have three factories in California making this material. They employ about 40 hands and make enough fuse to supply the wants of the mining regions as far east as Colorado, including British Columbia and northwestern Mexico.

WOOLEN MILLS AND GOODS.

Of the 40,000,000 pounds of wool annually produced in California, about one sixth is manufactured into various fabrics at home, and the remainder exported to eastern markets. There are eleven woolen mills now operating in the State, located as follows: two at San Francisco, and one each at Napa, Santa Rosa, San José, Marysville, Sacramento, Stockton, Merced, Los Angeles, and San Bernardino. A company with a capital of $100,000 has been formed and taken active measures for building a woolen mill at Gridley, in Butte County. The project of building a like establishment in Fresno County, and at one or two other points in the State, is now being considered, and it may safely be calculated that the present number of our woolen mills will be largely added to in the course of a few years. Those now running employ about 1,800 hands, one fourth of them Chinamen, the most of this race being employed in the two large mills in San Francisco. The capital invested in this branch of industry amounts to about $2,500,000—value of goods annually turned out, $3,200,000—wages paid out, $700,000 per year. The articles manufactured in this line consist mainly of blankets, flannels, cassimeres, cloths, yarns, and knit goods of various kinds. Our importations of woolen goods are heavy, and may be expected to so continue till buyers find out the superiority of our all-wool fabrics over eastern shoddy.

TEXTILE FIBERS AND FABRICS—SILK, COTTON, AND JUTE MILLS—SERICULTURE.

While we can grow in California all the fiber plants except such as are purely tropical, our advantages for the production of silk are notable—unequaled, perhaps, by those of any other country. The mulberry tree can be raised here with little trouble, growing much more rapidly than in France, and yielding more leaves. It has with us such power of recuperation that when trimmed down it throws up shoots from ten to fifteen feet in length in a single year, nor does it suffer under judicious cutting of this kind. Two crops of cocoons can be raised yearly, one in May, and the other in July, no artificial heat being required. Here we have none of that heavy thunder, and the long cold rains, that so injure the eggs and kill the worms in all parts of Europe. Here, instead of having recourse to kilns for stifling the chrysalis, as in other countries, this is effected simply by exposure to the solar rays, which, under the cloudless skies of California, is all sufficient. With a climate so equable and genial the cost of shelter is little. The worms so far have been free from disease, and there being no severe cold to interfere they work continuously. Incited by these favorable conditions, and the premiums offered by the State as an encouragement to sericulture, many of our people began planting the mulberry tree, procuring the eggs and breeding the worms more than twenty years ago. Barring such slight disappointments as arise from the mistakes incident to every new business, these efforts have been attended by the most gratifying results. We have now many millions of these trees growing in the State, and quite a large number, mostly women, girls, and boys, engaged successfully in the business of gathering the leaves, feeding, and otherwise looking after the worms. The calling is admirably suited to these classes, the labor being light, simple, and cleanly, while the methods of feeding, spinning their gossamer filaments, and the other habits of these strange creatures, are exceedingly curious and interesting. At first we procured the most of our eggs from Japan, those produced in France and Italy being at that time much diseased, and for several years these countries drew on us for more healthy eggs. Later we began to displace the Japanese with the Italian egg, which is now greatly preferred to any other. We have now two factories in this State, both located in San Francisco, engaged in making various kinds of silk goods, the one turning out skein, spool, knitting, and embroidery silks, and the other piece goods. The products of both these establishments are in great favor, being preferred by the trade to imported articles. These factories employ about 150 hands, mostly women and girls, and turn out aggregate values to the amount of $350,000 per year. Skilled laborers having been procured from Europe, these employés have been carefully trained, and are now adepts in the art of filature, weaving, and all else that relates to the manufacture of silk goods of the finest quality. The outlook for this industry, both as regards the production and manufacture of the fiber, is most encouraging in California.

Cotton.—Although cotton planting commenced in this State as early as 1870 no great progress has been made in the business, the retarding causes consisting mainly in the cost of labor and the considerable amount of it called for, the plant here requiring irrigation. The work of picking is also somewhat more laborious than in the Atlantic States, by reason of the dry Summers here causing the fiber to adhere more firmly to the stem. With irrigation, however, good crops can be made in the interior of the State, the yield being large and the staple excellent. The annual product of California has for some years past averaged about 250,000 pounds, seven eighths of it being raised in Merced, and the balance in Kern County. It has proved to the cultivators a fairly profitable crop, and more of it will probably be raised hereafter, as two companies have been organized for putting up cotton factories in the State, the one to be located in East and the other in West Oakland. These projects are in a state of forwardness, and being engineered by parties of ample means, will no doubt be pushed to an early completion. The mill at East Oakland will make jute as well as cotton goods, one of the specialties here being the manufacture of seamless flour and grain sacks. The conversion of the cotton factory erected at East Oakland in 1865 into a jute mill had a depressing effect on the cotton-growing interest of California by depriving planters of the limited home market they had before enjoyed. When it is considered that there is imported into the United States cotton fabrics, mostly fine goods, to the value of $40,000,000 annually, it would seem as if we on this coast ought to be able to grow cotton and manufacture it into the coarser kinds of articles to advantage.

Flax and Hemp.—That the cultivated flax would thrive in California might be inferred from the fact that the plant grows wild in many parts of the State. The indigenous stalk produces a good lint, of which the Indians formerly made much use. We have grown the plant here successfully for many years, but for the seed only, very little use having as yet been made of the fiber, though the stalk yields a strong heavy coat. The crop is a profitable one raised for the seed alone, for which the oil mills—two in the State—pay two and a half to three cents per pound, the yield of seed being at the rate of about 950 pounds to the acre. Our yearly product of this seed averages a little over 5,000,000 pounds. Of this quantity San Luis Obispo County turns out over 3,000,000 pounds; San Mateo, 1,400,000, and Santa Barbara 500,000 pounds. As our oil mills import flax seed largely, and the tendency of our people is to economy and the enlargement of our home industries, it may reasonably be expected that the cultivation of this plant will increase rapidly, and that the fiber, as well as the seed, will be utilized before many more years have gone by. The managers of the jute mill at Oakland having recently procured flax spinning machinery, with which they have made some excellent twine, are anxious to contract with flax growers for a quantity of the lint. The importations into the United States of the dressed fiber, and the linen made from it, amounted last year to $20,000,000, and yet no country is better adapted for growing flax than ours. While no crops of hemp have been raised in California, the experiments made with this textile plant demonstrate that our soil and climate are equally as well fitted for it as for flax, the stalk growing readily and yielding a strong and abundant fiber.

Jute and Ramie.—The attempts thus far made at cultivating ramie in California have been discouraging, the plant being liable to suffer from frost, and yielding but little fiber. The experiments made with jute, however, proved entirely successful, and there is little doubt but our tule lands, when reclaimed, will afford millions of acres well suited for growing this plant. Some trials made along the sloughs of the Sacramento have turned out extremely well. Growing jute on these tule lands and river bottoms would be attended with the further advantage of having water convenient for rotting the stalk. In view of the large demand for grain sacks on this coast, jute is sure to be grown here on an extended scale. It is estimated that our requirements for the present year, Oregon and Washington Territory included, will amount to over 45,000,000 sacks; which, making due allowance for sacks used a second time, would cost our farmers annually not less than $3,000,000. The principal hindrance to raising jute here is the fact that our cultivators would have to contend with the cheap labor of India, whence the entire supply of the world is at present derived. But as the home producer would have freights, duties, and insurance in his favor, it would look as if he ought to be able to compete successfully with the India grower, our soil and climate being probably as well adapted for raising the plant as his; not only so, but were our people to engage largely in the cultivation of jute, it may be presumed that we would soon invent machinery for dressing the stalk and preparing the lint for spinning, a process effected in India altogether by hand labor.

We have now two jute mills engaged in spinning this fiber and making the yarn into grain sacks, the one located at Oakland and the other at the San Quentin Prison, the latter being the property of the State. These mills, which employ from 400 to 500 hands each, are run to their full capacity for the greater part of the time, and turn out between 8,000,000 and 10,000,000 grain sacks per year, cotton sacks for flour, salt, etc., being also made at the Oakland mills. The sewing of these sacks is done partly by hand and partly with powerful machines constructed for the purpose and imported from Dundee, Scotland, where are located the most extensive jute factories in the world. The original cost of these machines, three in number, was $1,300 each—cost, delivered and set up here, $1,500. The output of the Oakland mill averages now about 5,000,000 grain sacks per year; of the San Quentin mill, about 4,000,000.

SUGAR—IMPORTATION, PRODUCTION, REFINERIES, ETC.

As yet California has done but little towards supplying herself with sugar, about all that has been accomplished in that direction being the production annually of less than 1,000 tons of sugar made from beets. The quantity of sugar beets raised in the State amounts to about 70,000 tons per year—40,000 tons raised in Alameda County, 20,000 in Los Angeles, and the remainder mostly in Sacramento County. There are four beet sugar factories in the State, one at each of the following places: Alvarado, Soquel, Sacramento City, and Isleton, the most of the sugar thus far produced having been made at Alvarado, in Alameda County. Some sugar cane has been raised in the southern part of the State and some sorghum elsewhere, but no sugar has been made from either, the first having been consumed by our cane-chewing population, and most of the sorghum used for fodder. As our soil and climate are exceedingly well adapted for the growth of the melon, it may be expected that a great deal of sugar will yet be produced here from that vegetable. Much has been said and written calculated to favor experiments with the melon sugar. Among those who have made valuable contributions to the literature of this industry, Wm. Wadsworth and Dr. J. S. Silver, of this city, are entitled to special mention. Extracts from these papers are given below. For refining the raw sugar imported into this State three large establishments have been erected in San Francisco, the most extensive of these, the California Sugar Refinery, lately completed, having cost over $1,000,000. These several establishments give employment to more than 500 hands, and use up every year over 120,000,000 pounds of raw sugar; value of products, $8,000,000 per year. Our imports of this article for 1883 were 103,932,158 pounds from the Sandwich Islands, and 20,183,301 from Manila, with some small lots from Central America and other sources. Our shipments of refined sugar east amounted last year to 32,576,080 pounds; shipments to foreign countries, 2,483,116 pounds.

CIGARS—MANUFACTURE, CONSUMPTION, ETC.

Although we raise but little tobacco in California, the business of manufacturing this article into cigars and other forms for use has reached here very large proportions, there being over 5,000 hands engaged in it, more than three fourths of them Chinamen. While the larger factories, all in San Francisco, are carried on by whites, many of the smaller are in the hands of the Chinese. Efforts have been made at various times to displace Chinese by white labor, but thus far without success. Some of the larger companies employ as many as 350 hands, and turn out over 6,000,000 cigars annually. The number of these articles made in the State last year amounted to 171,975,450, the entire quantity of tobacco worked up nearly 5,000,000 pounds, being valued at $10,700,000. In addition to the above 24,000,000 cigars were imported, some from Chicago and other places in the East and some from Cuba, with a few cheroots from Manila. We import nearly all our leaf tobacco from the Eastern States, the bulk of it coming from Connecticut and Pennsylvania. Some Mexican and Spanish manufacturers obtain their leaf from Havana. To foreign countries our exports in this line are small, though we supply cigars and cigarettes to all parts of the Pacific Coast, competing for this trade successfully eastward to the Missouri River. While the even temperature of our climate tends to improve the leaf, the products of our factories are said to be noted for their good appearance and finish. But for the prejudice entertained by certain classes of smokers against home-made articles generally, the importations of cigars would probably have ceased long before this.

As the price paid for making cigars is considerably less in San Francisco than in New York, we ship over 1,000 cases, mostly of cheap grades, every year to eastern markets; and when we succeed, as we ultimately will do, in raising our own leaf, the prospect is that a heavy trade will grow up in that quarter. Encouraged by war prices the cultivation of tobacco was undertaken in this State more than twenty years ago. Rich bottom lands having been selected the leaf first grown was too rank, and, having been badly cured, failed to meet with favor, though a very fair article of plug tobacco was made from it. Some plantings made afterwards, on more favorable soil, whereby the above defect was corrected, produced a leaf that served well for wrappers. Of late years but little tobacco has been grown in the State. The quantity raised in 1882, as reported by the Surveyor-General, was 26,590 pounds, grown on 27½ acres—25,000 pounds of this having been grown in Los Angeles County. Last year a lot of tobacco was raised near Colton, in San Bernardino County, which, though of a slightly pungent flavor, was much commended by the experts for its good qualities, having been pronounced equal to the best Virginia leaf in point of body and mildness. Despite some discouragements in the past the growing of this plant may be reckoned among the coming industries of California.

FISHERIES, SALMON CANNERIES, ETC.

The canning of salmon, though largely engaged in further north, is not an extensive industry in California, only twenty of the ninety canneries on the coast being in this State, the most of them located between Collinsville and Vallejo. Some of the fruit canneries in San Francisco also carry on the business of salmon canning, the season for the latter coming in before the fruit canning season becomes very active. The largest portion of the catch is made on the Columbia River, along the banks of which are located thirty-six canneries, which employ for taking the fish 1,600 boats, managed by two men each. The business is prosecuted on several other rivers in Washington Territory and Oregon, also on Fraser River, British Columbia, along which there are fourteen canneries. Some canning is done elsewhere in that country, also in Alaska, the fish taken in these northern waters being noted for their excellence. The entire pack of the coast amounted last year to 1,120,000 cases, the quantity salted and packed in barrels being equivalent to 60,000 cases more, the whole worth, at the rate of $25 per case, $5,600,000. The salt fish sell for about five cents per pound; after being smoked, for a little more. When the canneries have more fish than they can readily put up, and when retailers have more than they can sell, the surplus is salted. Fish caught out of season, or at localities where there are no canneries, are also disposed of in this way. We import salt mackerel, herring, etc., largely, but not much cod of late, our supply of this fish coming mostly from the North Pacific. The San Francisco market is well supplied with both salt and fresh water fish of almost every kind, some of the fish introduced into our waters, such as carp, shad, mackerel, etc., beginning now to make their appearance on the stands of the retail dealers. Our gourmands devour about 50,000 frogs every year, these amphibious creatures selling at the rate of $3 per dozen in San Francisco.

WIRE WORKS.

The wire mill and wire rope factory, under the same general management, and which may be said to constitute one establishment, are situated in the northern part of the City of San Francisco. At the former, wire of all sizes and every description is drawn from copper, brass, iron, crucible and Bessemer steel. At the factory the products of this mill are wrought into every style of article made of wire or into the manufacture of which it largely enters, such as rope, cloth, cables (round and flat), barbed wire for fencing, screens, fenders, trellis-work, chairs, sofas, baskets, bird cages, etc. Some very heavy work has been turned out at this establishment. Here was made last year the cable now in use on the Market Street Railroad, 22,000 feet long, one and five sixteenths of an inch thick, and weighing nearly 60,000 pounds. The cables in use on our other street railroads, also most of those placed in the hoisting works on the Comstock Lode, came from this factory. Connected with these works, which are very extensive and complete, are a galvanizing department, machine shop, foundry, etc. They employ a total of 100 men and 15 boys. The sum paid out for wages here amounts to $120,000 per year; value of products made, $400,000.

THE PACIFIC SAW COMPANY

Manufacture at their works in San Francisco saws of every description, the making of circular, gang, and crosscut saws constituting, however, the bulk of their business. This enterprise, started in 1866 with a capital of $24,000, all invested in stock, tools, and machinery, has proved a marked success, owing to the excellence of the wares turned out by the company, who employ 30 men at wages ranging from $2 to $6 per day, and produce goods to the value of $110,000 annually. The circular saws of this company are in use all over the coast to the almost entire exclusion of every other. They also supply these articles to the west coast of Mexico, Central and South America, and even send some into the regions east of the Rocky Mountains. Although this company have heretofore procured most of their steel from Pittsburgh and Sheffield, the probabilities are that they will hereafter make use of the home-made article. By reason of this establishment importations of saws into California have been greatly diminished, amounting of late to hardly more than 2,000 dozen hand and 1,000 dozen crosscut saws per annum.

CORDAGE.

There have been two cordage factories started in California, the one by the San Francisco and the other by the Pacific Cordage Company. The works of the former, erected by the Messrs. Tubbs in 1856, are located at the Potrero, in the southern part of the city. The works of the Pacific Company, erected in 1877, are located at Melrose, in Alameda County; when running, the latter employed 90 hands, and had capacity to turn out 2,000 tons of rope per year. The sounding-lines used in making surveys for the Pacific Ocean Telegraph Cable, some of which were ten miles in length, were manufactured here. It having been found that the two factories were turning out wares greatly in excess of trade requirements, operations at Melrose were suspended, as a means of averting what otherwise would have proved a ruinous over-production. The Potrero establishment, having since been run to its maximum capacity, has worked up raw material at the rate of 6,000 tons per year, the rope made amounting to 20 tons daily. This factory employs 150 men, at wages said to be seventy-five per cent higher than are paid in Europe, and turns out products to the value of $750,000 yearly. The fiber used here consists of Manila hemp and sisal from Yucatan, nearly every kind of cordage, from the heaviest ship hawsers to hay rope, being manufactured, all of a quality equal to the best imported. More than a third of all the rope made here is used by the farmers for baling hay, binding grain, etc., much being also required for hoisting purposes in the mines, repairing the rigging of ships, etc. Our imports of cordage during the past two years have been as follows: 1882, 4,058,410 pounds; 1883, 1,676,941 pounds; the quantity imported having been greater in 1882 than for many preceding years. Our exports in this line are inconsiderable.

A small factory at Portland, Oregon, supplies that State with cordage, at least, in part.

HOSE AND BELTING.

There are four factories on this coast, all in San Francisco, engaged in making hose and belting. They give employment to 45 hands, and turn out annually about 200,000 feet of leather belting, 7,000 feet of hose, and 180,000 feet of lacing, of the total value of $260,000. Our exports in this line are small, not over $50,000 worth per year, the magnitude of our mining operations and the extent to which hand irrigation is practiced here, causing a large consumption of this class of goods. Of leather hose and belting, we import but little, the products of our home factories being greatly superior to anything we are able to obtain abroad. Our importations of rubber belting and hose are, however, heavy, their value approximating $800,000 yearly. The industry under consideration has been with us a very prosperous one and is likely so to continue. Commenced in 1857, it has grown slowly but steadily ever since, the great excellence of California tanned leather having contributed largely to its success.

HARNESS, SADDLERY, WHIPS, ETC.

By reason of the much teaming, staging, packing, and riding that in this State became necessary, the manufacture of harness, saddles, etc., commencing here at an early day, grew speedily into a large and profitable business, few industries in California having paid better than this. Even before the American occupation of the country, the riding accouterments of the native Californian had become noted for their excellence. With those who ride much, the Spanish saddle is still preferred to the English, to which it is, in fact, greatly superior, both as regards durability, comfort, and safety. Owing to the severe service required of it, our workmen have been trained to make only harness of the best kind; hence, for these equipments, we have had the entire market west of the Rocky Mountains. It has also been our custom to export yearly about $75,000 worth of heavy harness and Spanish saddles to the Sandwich Islands, to be used mostly on the sugar plantations there. Our annual expenditure abroad, for this class of goods, does not exceed $75,000, mostly made for fine harness, side-saddles, etc. About $15,000 worth of these goods are imported from England, the rest from the Eastern States. Nearly everything in this line is made of California tanned leather, only a little harness leather of extra fine quality being imported. There are no very extensive manufactories of these articles in California, the business being carried on mostly in small shops all over the country. There are probably in the State 800 men employed at this business, the value of the goods manufactured amounting annually to about $2,000,000—

money paid out for wages, $400,000, workmen being paid from $2 to $3 50 per day.

At some of the harness shops a few whips are made, there being but one factory on the coast, that of Keystone Brothers, San Francisco, devoted exclusively to that business. This firm employs about a dozen hands, and manufactures reatas, headstalls, Mexican bridle reins, etc., to the value of $25,000 a year. The value of the whips manufactured in the State, amounts to about $30,000 per year, with nearly as many more imported. The latter consist mostly of carriage and buggy whips, which, though of more stylish appearance, do not wear as well as the home made article. Most of the materials used in this business, such as leather, rattan, whalebone, glue, etc., are of domestic production.

CATALOGUE AND DESCRIPTION

OF THE

MINERALS OF CALIFORNIA

AS FAR AS KNOWN,

WITH SPECIAL REFERENCE TO THOSE HAVING AN ECONOMIC VALUE.

ALPHABETICALLY ARRANGED.

INTRODUCTION.

Before entering upon a description of the minerals that occur in California, it may be proper to note the changes that have taken place in our industrial affairs, also the altered conditions of labor and capital, and explain how it is that these valuable products have been so little utilized, lest such neglect be construed to mean that the State is deficient in resources of this kind, than which nothing could be more erroneous.

The principal obstacle in the way of our turning these forms of our natural wealth to practical account, has been the high prices of capital and labor that for a long time obtained here, rendering it cheaper to import such commodities as we required in this line of consumption than to produce them at home, even though we had the raw material in abundance. For many years these two prime factors of production were from three to five times as dear in California as in most other countries. In 1848–9 common labor commanded here from $10 to $12 per day; and, although the price declined in the course of three or four years to less than half these rates, and afterwards underwent a still further reduction, it remains still from fifteen to twenty per cent higher than in the northern Atlantic States, the wages of mechanics, miners, and artisans, being here proportionately higher than those of farm hands and other unskilled laborers. As with labor, so with capital—money, while it commands no longer the excessive rates of interest formerly obtained for its use, is still from twenty to twenty-five per cent higher here than in the States east of the Missouri River. Meantime, while these elements of production remained so much higher than in any other part of the world, ships in great numbers began to come here to load with wheat, bringing iron, salt, sulphur, cement, glass and earthenware, fire bricks, and such other articles as suffer little harm from a long sea voyage, at low rates of freight—sometimes as ballast. If, after this wheat traffic had reached large proportions, inaugurating an era of low freights, the local demand for any of these commodities happened to be such as seemed likely to encourage their manufacture being undertaken here, straightway the importer and the foreign producer combined to flood the market, or by other means managed to so depress prices as to prevent the contemplated enterprise being engaged in, or to crush it out if already undertaken. And thus, for a time, were residents of California deterred from trying to produce this class of articles at home, well knowing that they would be forced to struggle against a ruinous competition if they sought to do so. And, then, not always at first could such skilled labor be commanded here as was required for the successful prosecution of these new industries, few trained artisans or handicraftsmen caring to come to a country so remote and offering so little chance for steady employment.

Besides these more general there existed diverse minor hindrances to the establishment and growth of these special pursuits in this State, such as restricted consumption, sudden fluctuation in prices, cost of fuels, and sometimes too much home competition, a number of enterprises of this kind having come to grief through excessive local rivalry coupled with a limited market. Over-production has, in fact, proved disastrous to two or three of our domestic industries, and something of a detriment to several others. The production of more borax and quicksilver than the markets of the world could absorb has diminished the profits of these pursuits to a minimum. The facility with which salt can be made on this coast, combined with heavy importations, have reduced this business to nearly the same condition. Other cases of like purport might be cited.

Sharp vicissitudes in prices have not been so common of late years as formerly, when, nearly everything being imported, and being often a long time on the way, an unexpected scarcity might easily occur, and when, also, it was comparatively an easy thing to effect corners in the market. The want of a cheap smelting and coking coal has been a serious and ever present obstacle to the growth of the iron interest, also to the reduction of certain ores, as well as the manufacture of glass, earthenware, and many other articles.

But the most of these adverse conditions having disappeared or been so modified that they are no longer formidable, many of these useful products of nature are destined to be made industrially and commercially available in the near future, a good deal having already been accomplished in that direction. If labor in California is a little dearer than in the older States of the Union, it is nevertheless in good supply and generally disposed to act in harmony with capital, nor is there much reason to apprehend that any serious conflict will soon arise between these producing forces. The working classes, by reason of the healthfulness of the climate and the cheapness of the staples of subsistence, perform their tasks with such comparative comfort that we have here less insubordination and complaint than is common in most other countries. What adds to the general contentment is the extent to which the migratory spirit incident to the gold-mining era has given place to proclivities of an opposite tendency, the inhabitants of California, from being the most nomadic of all peoples, being noted now for their stability and love of home. Hence it has come to pass that the State is being populated by a race that can be depended upon, in so far, at least, as fixity of residence is concerned. Out of this disposition to abide in one place there has grown a necessity for the on-coming generation to make the most of their local resources; wherefore, a variety of metals and minerals are beginning to be sought after, which, in earlier times, received little attention or were wholly overlooked.

While the precious metals continue to hold, as they long must hold, a prominent place in the mining industries of California, coal, iron, copper, chromium, mica, antimony, asbestus, the useful clays and mineral fertilizers, cement, lime, gypsum, and the like, are every year becoming more and more the objects of research and enterprise, nor is there any doubt but these substances, so long regarded as of secondary importance, will, in the end, do more to advance the permanent interests of the State, and otherwise prove of greater intrinsic value than gold or silver. And, certain it is, no people ever have or ever can become rich, prosperous, and progressive, who confine themselves to a narrow field of industry, the impolicy of such a course being well illustrated by the backward condition of Russia, Spain, Egypt, Mexico, and nearly all the republics of Central and South America. Owing in a great measure to this cause, so long as the Southern States raised only cotton and sugar, many of the inhabitants remained ignorant and impoverished, the tendency in every country where but a single or a few staple articles are produced being to divide the population into two classes, the proprietary and the servile—the rich and the poor. Were California to produce nothing but wheat, wool, wine, and gold, she would still be wanting in the best elements of the higher civilization, no matter how much of these valuable commodities she might be able to grow or gather every year. Our people enjoy a larger aggregate of physical comforts, and are every way better off now than when gold mining constituted their principal and almost sole employment—varied pursuits are a great equalizer of rank and distributor of riches. Things made at home, besides giving employment to labor, retain in the country the money it would cost to obtain them abroad.

But while a system of diversified industries is so essential to the well being of every community, the establishment of such a system is a work of time, and requires to be gone about with deliberation and caution; we of California having in numerous instances engaged in mining and manufacturing enterprises prematurely or without taking those precautions that ordinary prudence and business sense would naturally suggest. Hence the considerable number of failures that has attended these undertakings, scarcely any of which have caused disappointment except where so unadvisedly entered upon. One prolific source of disaster to ventures of this kind has been the misleading character of the reports emanating from prospectors and claim locators, vouched for and very often amplified by the local press. Relying on this sort of authority a great deal of money has, one time and another, been wasted in searching for ore where little or none existed, such expenditures being sometimes supplemented by others for reduction works where, of course, none were needed. The prospector for mineral deposits is apt to be of an ardent and hopeful temperament. But for those mental idiosyncracies he would not be likely to engage in the business. Being so constituted he becomes often the victim of the grossest self-deception, and is thus prepared to honestly deceive others. What to a less sanguine person might seem hardly an encouraging indication is to him proof positive. Others, confiding in his statements, are exposed to disappointment. As the losses resulting from these mistakes do not always fall on the parties causing them, their occurrence is much to be deplored. Besides the damage inflicted on those more directly concerned, they react unfavorably on the business of mining and manufacturing generally, their tendency being to discourage exploration, and deter capitalists and others from embarking in legitimate undertakings.

It is useless to claim for California forms of mineral wealth that she does not possess, nor can any good come from encouraging others to engage in any pursuit prematurely, or without their having first carefully canvassed the chances for success. Our past experience admonishes us to avoid precipitate action in matters of this kind. One fourth of the quartz mills and smelters put up in the mines are idle, and in the suburbs of many a mining town in the State may be seen deserted reduction works, refineries, and factories of various kinds, some because they were attempted to be operated by processes inherently defective, but more because of an insufficient supply of ore or other material to keep them profitably employed. The cement mills near Benicia have been idle for years. The small antimony works put up in San Francisco can be run but part of the time through lack of ore, the larger establishment of this kind erected in West Oakland having, for the same reason, succumbed some time ago, and yet, to read the published accounts of our antimony deposits, it would be supposed that we had enough ore of this sort to supply the wants of the entire world. The same thing was being said a few years since about our cement beds, which it was claimed were of the best quality, yet the experiment proved a failure, consumers preferring the imported article. We have, it is said, sand suitable for making the finer kinds of glass, and yet our glass makers are perverse enough to go all the way to Belgium for this material. We have no doubt good clays in California, and yet we do not keep out the English fire-bricks. These remarks are not made with a view to disparage our mineral resources, or to discourage their development, but for the purpose of emphasizing the importance of greater caution, both in the inauguration and subsequent conduct of mining and other industrial enterprises. It has been our purpose to embody in this report none but information of a reliable character. In the absence of pecuniary means to visit and examine more than a few of the many mineral deposits reported, the State Mineralogist has been compelled to accept second hand certain information in regard to the character and value of these deposits, giving the same for what it is worth. It is not, therefore, expected that the data here supplied will alone suffice as a safe basis for important industrial enterprises and business transactions. Where these are contemplated, further inquiry should be made, and in so far as possible, more full and reliable information be obtained. The principal object of this report, pointing out where the more valuable minerals occur, and the extent to which they have been recovered from nature and converted into useful forms, has, however, it is hoped, been reasonably attained.

It may here be explained that this report, being designed for the non-professional reader, rather than the skilled scientist, has been prepared with special reference to the wants of the class for whom it is mainly intended. The various subjects discussed have, therefore, sometimes been treated with an amplitude that, to the trained expert and such as have always access to authorities, may seem prolix and even superfluous. The controlling idea in the preparation of this paper has been to furnish the manufacturer, mechanic, and artisan such information as will be of service to them in the prosecution of their several callings, and to supply the prospector and miner with plain rules by which they will be able to recognize most ores and minerals found in this State, and to employ simple tests for their determination, when this cannot be done by the eye. If the skilled chemist, mineralogist, and assayer, and such others as have had the benefit of a technical education, may not much feel the need of this sort of information, it is still hoped that the classes for whom it was more particularly intended will derive from this paper some benefit, and that even the millman and practical metallurgist will find in it hints that may prove serviceable to them in their difficult vocations.

It has been thought best to reprint in this report certain parts of former ones bearing specially on the minerals of the State, both to save the labor of rewriting and because editions of the first reports have long since been distributed and are not always attainable for reference.

CALIFORNIA MINERALS.

Actinolite—see Amphibole.

1. AGALMAMOLITE. Etym. "*An Image*" (Greek). Pagodite—from *Pagoda* (Chinese). Chinese figure stone, a variety of pinite, hydrous silicate of alumina, magnesia, iron, lime, soda, and potash.

It is much used for ornamental carved work by the Chinese. A number of specimens from that country appear in the State Museum. No. (4060) in the Catalogue, from San Luis Obispo County, much resembles this mineral, as does also (5300), from Greenwood, El Dorado County, which occurs in a vein from six inches to a foot in thickness. These specimens have been so labeled with an interrogation, pending an analysis, when the State Mining Bureau has a suitable laboratory.

Agate—see Quartz.

Alabaster—see Gypsum.

2. ALBITE. Soda Feldspar. Etym. *Albus* (white), from its color.

It is, when pure, a silicate of alumina and soda, as follows:

Silica	68.6
Alumina	19.6
Soda	11.8
	100.0

Part of the soda is sometimes replaced by potash and other elements and compounds, as lime, magnesia, etc. There are numerous varieties of Albite under different mineralogical names. The true Albite has not been found in California, in distinct masses, as far as my experience goes. Dana gives as a locality the vicinity of the Murchie mine, Calaveras County, with gold and pyrite.

The crystalline and plutonic rocks of California have not been studied as they should be, but an abundance of soda, resulting, probably, from their decomposition, would seem to indicate that Albite, in some form, enters largely into their composition.

3. ALTAITE. Etym. *Altai mountains of Asia.* Telluride of Lead.

Has the following composition:

Lead	61.7
Tellurium	38.3
	100.0

Color, that of metallic antimony with a shade of yellow—luster metallic H. 3—3.5, sp. gr. 8.2, on ch. in R. F., colors the flame blue, entirely volatile when pure, but leaving in some cases a trace of silver. The ch. becomes coated with telluride of lead and litharge. The former with metallic luster, and the latter yellow and dull. As tellurium minerals are rather common in California, the most important and interesting facts concerning this rare element will be given under the head of "Tellurium," with tests for its determination.

Altaite is said to be found at the Rawhide Ranch gold mine, Tuolumne County, in small quantities, but as no analysis has been published, there is some doubt as to its identity. It has lately been reported at the Frenchwood mine, Robinson's Ferry, Calaveras County, according to Z. A. Willard, with Petzite, Calaverite, and other tellurium minerals, and gold; also at the Morgan mine, Carson Hill, Calaveras County, in large masses, with gold, and at the Adelaide mine, in Tuolumne County. Dana gives the Golden Rule mine, Tuolumne County, as a locality.

4. ALUM. Etym. "*Alumen*" (Latin), as generally understood, is a hydrous sulphate of alumina and potash, as follows:

Sulphate of alumina	36.2
Sulphate of potash	18.3
Water	45.5
	100.0

It is produced artificially by adding the deficient elements to the leachings of calcined alum shales. When natural, the mineral is called *Kalinite.*

When ammonia replaces potash, the mineral is Tschermigite. These minerals and soda alum, or Mendozite, resemble each other in taste and appearance. There are several localities in the State where native alum has been found, but the minerals have not been analyzed, for which reason their exact composition is uncertain. It has been found as an incrustation ten miles north of Santa Rosa (4468), near Newhall, Los Angeles County (4404). Alum slate occurs near Auburn, Placer County (4249), and (4250) is alum crystallized from it. Alum in thick incrustations has been discovered at the Sulphur Bank, Lake County, in considerable quantity (1108), at which locality other sulphates are abundant. This mineral is thought to be Tschermigite, but no analysis has been made to prove it.

Alum is said to occur at Silver Mountain, Alpine County, on Howell Mountain, Napa County, and at numerous localities, as an incrustation on certain rocks. I have seen it crystallized on the bare rocks washed by hydraulic streams in gold mines near Dutch Flat, in Placer County, and in Nevada County. When all conditions are favorable in the State, alum will perhaps be largely produced, and there seems to be no reason why it should not be.

Amianthus—see Amphibole.

5. AMPHIBOLE. Etym. "*Doubtful*" (Greek). Actinolite, Anthophyllite, Amianthus, Asbestus, Hornblende, Mountain Cork, Mountain Leather, Tremolite, etc.

Amphibole is an anhydrous silicate of various bases—iron, magnesia, lime, etc.—generally containing a little water.

ACTINOLITE (Ray stone) is rather abundant in the counties bordering on the Bay of San Francisco. It is found in bowlders, or rolled masses, in Alameda and Contra Costa Counties, which, when broken, show beautiful green radiating crystals. It is found in some rocks of the Coast Range, near Knight's Ferry, Stanislaus County; also at Petaluma, Sonoma County, with garnets (Blake); on the Mariposa estate, Mariposa County, in fine needle crystals; and in quartz, Eagle Gulch, Plumas County (Edman). The following specimens may be seen in the State Mining Bureau: (3431) twelve miles from Gilroy, Santa Clara County; (4213) Eureka, Humboldt County; (4335) Santa Rosa, Sonoma County; (4339) Spanish Ranch, Plumas County.

Although this mineral is very interesting to science, and is found in beautiful cabinet specimens, it has no economic value.

ANTHOPHYLLITE, named from its clove brown color, is said to be found at Slate Range, San Bernardino County.

ASBESTUS, *Amianthus*, is named from Greek words, meaning incombustible. It occurs in long fibrous masses, which are silky in appearance. The fibers in the best quality can be separated and twisted into threads, which may be woven into cloth. This mineral was well known to the ancients, who utilized it in numerous ways. The wealthy Romans are said to have used the cloth for napkins, which each took to banquets for personal use. When soiled the napkins were thrown in a fire, and burned white and clean. The following is a quotation from Pliny's Natural History, Book 19, Chapter 4:

> There has been invented, also, a kind of linen which is incombustible by flame. It is generally known as "live linen," and I have seen before now napkins that were made of it thrown into a blazing fire in the room, where the guests were at table, and after the stains were burned out, came forth from the flames whiter and cleaner than they could possibly have been rendered by the aid of water. It is from this material that the corpse cloths of monarchs are made, to insure the separation of the ashes of the body from those of the pile. This substance grows in the deserts of India, scorched by the burning rays of the sun. Where no rain is ever known to fall, and amid multitudes of deadly serpents, it becomes habituated to resist the action of fire. Rarely to be found, it presents considerable difficulty in weaving it into a tissue, in consequence of its shortness. Its color is naturally red, and it only becomes white through the agency of fire. By those who find it, it is sold at prices equal to those given for the finest pearls. By the Greeks it is called "Asbestinon," a name which indicates its peculiar properties.

Asbestus has been found at numerous localities in California, the best quality being from Butte County, eighteen miles north of Oroville. (1677, 1678, 1842) are specimens from this locality. The fibers are long and fine, quite equal to the best Italian. It is found also in Del Norte County, Salt Spring Valley, Calaveras County, Los Angeles County in large masses (Blake), Jenny Lind Hill (Trask), San Diego County, near Caliente, San Bernardino County, Key's Tunnel, California Mine, Yolo County (449), Shasta County (1293), White River, Tulare County (2419), Mount Bullion, Mariposa County (2437), Bear Valley, Mariposa County (4464), in the Inyo Mountains, Inyo County, and elsewhere in the State. At least one company has been organized to work asbestus deposits in California. The United Asbestus Manufacturing Company was incorporated June 22, 1883, for the purpose of manufacturing, selling, and dealing in asbestus. Their mine is in Placer County. The Swiss Boys and Leeds claims are on the right bank of the American River, one mile below Rice's Bridge. The following recently appeared in the Fresno Republican:

> W. P. Litten and B. Greenley, of Grub Gulch, called at the Republican Office, and exhibited specimens of asbestus taken from ledges recently discovered in French Gulch, in the Potter

Ridge mining district. The specimens shown us appear to be a fine article, and the gentlemen claim for it that it is equal to the best quality used for manufacturing purposes. They are of the opinion that this valuable mineral exists in paying quantities, and as soon as this fact is thoroughly demonstrated the attention of capital will be enlisted and this new source of mineral wealth developed.

The uses of Asbestus are various, which, however, may be, briefly stated, for paints, coating for boilers and steam pipes, indestructible lamp wicks, packing for steam engine cylinders, roofing, filling fire-proof safes, boards for flange joints, etc.

It is as yet uncertain how extensive the deposits of California may prove to be. There is a demand in the world for all that is likely to be produced, and the manufacture is in the hands of a few, who, to a certain extent, dictate prices. Fifty dollars per ton has been offered for asbestus of good quality and long fiber; for an inferior quality $25 only can be obtained; the price in New York is from $15 to $60, according to quality. The finest Italian commands from $100 to $250 per ton, governed by quality and the state of the market.

HORNBLENDE—From *Horn and Blende* (German) enters into the composition of many of the rocks, as syenite, diorite, gneiss, porphyry, etc., and it sometimes is found in rock masses. It has no economic value except as a building stone. It is found in California at San Pablo, at Soledad, and at Vallecito; near Murphy's, Calaveras County (Blake), at Gold Run, Placer County (4266), Healdsburg, Sonoma County (2263), Folsom, Sacramento County (2913), and as a constituent of certain rocks over a large area of the State.

MOUNTAIN CORK, so named from its resemblance to cork, is found in Tuolumne County (Blake). It has no value in the arts.

MOUNTAIN LEATHER, a similar mineral, has been found in Tuolumne and Mariposa Counties, and at the Little Grass Valley mine, Pine Grove district, Amador County (4336, 4727).

TREMOLITE, named from Tremola, a valley in the Alps, where it was first discovered, is found white and fibrous in limestone, in Columbia, Tuolumne County (Blake), Santa Cruz Mountains, Santa Cruz County (2129).

6. ANDALUSITE. Named from Andalusia, a province in Spain, where it was first found, is a silicate of alumina, containing sometimes sesquioxide of iron, magnesia, lime, soda, potash, and manganese in varying proportions. When pure it has the following composition:

Silica	36.8
Alumina	63.2
	100.0

The California mineral is known in mineralogy as Macle, or *Chiastolite*, from the markings and the forms of the crystals; the former name is from the Latin *Macula* (a spot), and the latter from the Greek letter X.

Andalusite is found in large quantities in the slates cut by the Chowchilla River, near the old road to Fort Miller, Fresno County, and in the conglomerate which caps the hills; in the slates at Hornitos, in Mariposa County; at Moore's Hill, Mariposa County; twelve miles south of Mariposa; at Moore's Flat, same county; near Ne Plus Ultra mine, Fresno County.

In the State Museum (4450) is a piece of clay slate, with Andalusite crystals imbedded. Some of the crystals are five inches long, and from one half inch to an inch thick. This mineral is known to the miners as "petrified nails." The ends of the crystals show the characteristic markings and crosses peculiar to the species; these are much better seen when transverse sections are cut and mounted for the microscope. Few objects have the rare beauty of this mineral, when well prepared and examined with a two-thirds objective and lighted with an achromatic condenser or parabola.

Several sections now in the State Museum, cut by Mr. Melville Attwood, of San Francisco, were exhibited at the Paris Exhibition of 1878, and attracted considerable attention. The nebulous cloud of black particles, as seen under the microscope, strongly resemble magnetite in slices of basaltic rocks seen under the same circumstances. This mineral has no economic value.

ANDRADITE—see Garnet.

7. ANGLESITE. Etym. "*Anglesea*," an island on the coast of Wales.

Is a natural sulphate of lead, called also "lead vitriol." Composition (PbO, SO_3):

Sulphuric acid	26.4
Oxide of lead	73.6
	100.0

H. 2.75—3, sp. gr. 6.12—6.39, occurs in transparent crystals and amorphous.

Anglesite may be distinguished by the following reactions: B. B. on ch. it fuses easily and is reduced to a sulphide; at this stage a small portion removed from the charcoal, placed on a clean silver coin and wet with water will produce a black spot which cannot be removed without considerable rubbing. On ch. if the R. F. is continued for some time, with addition of soda, a globule of lead is obtained and the ch. is coated yellow. If the lead is afterwards cupelled, a button of silver is generally obtained if the specimen was amorphous.

It is rather a common mineral in California, and exceptionally so at the Cerro Gordo mines, Inyo County, where it assumes a compact form, unlike any described variety found elsewhere. These deposits have been extensively mined for lead and silver; and although the shafts have attained considerable depth, no water has been met with, even in the lowest workings.

Anglesite is found in these mines in large masses, and in nodules inclosing Galena, from which it is evidently a pseudomorph. When these masses are broken the Anglesite is frequently found in concentric shells of different colors, like agate. Large crystals are uncommon; but a microscopic examination of freshly broken surfaces will often reveal crusts of exquisite transparent Anglesite crystals, associated with other lead minerals.

Anglesite in California is a valuable and abundant ore of lead, often very rich in silver, and always carrying a notable portion of that metal. It is found, also (1648, 1668), with Bindheimite, Azurite, and Galena, at the Modoc mine, Inyo County; with Galena at the Cerro Gordo mines, Inyo County; with Argentiferous Galena, at the Santa

Maria mine, Cerro Gordo, Inyo County, and at the Eclipse mine, in the same county, with Azurite and Galena.

8. ANHYDRITE. Etym. "*Without Water*" (Greek). Anhydrous Sulphate of Lime, Anhydrous Gypsum.

Color generally white; sometimes gray, blue, or red. H. 3–3.5, sp. gr. 2.9–2.98. Composition:

Lime	41.2
Sulphuric acid	58.8
	100.0

It is slightly soluble in water, and when exposed to the action of the elements it slowly changes to Gypsum. It would, therefore, be useful as a fertilizer, but it cannot be used in the manufacture of plaster of Paris. This mineral is not common in California; the only locality known to me is near Anaheim, Los Angeles County. The mineral is white, semi-crystalline, translucent, resembling crystalline marble, and could be made a beautiful ornamental stone. Dana, in his California Mineral Localities, gives near Santa Maria River, Los Angeles County; this may be the same as above.

Anhydrous Sulphate of Soda—see Thenardite.

Anthracite—see Mineral Coal.

Antimony—see Cervantite and Stibnite.

Antimony Ochre—see Cervantite.

Antimony Sulphide—see Stibnite.

9. ARAGONITE. Etym. *Aragon*, a province in Spain. See, also, Marble, under the head of Calcite.

When pure it has the following composition:

Carbonic acid	44.
Lime	56.
	100.

It is not uncommon in California. It is most frequently found as a deposit by mineral springs. It occurs, also, in the underground workings of gold and silver mines, and often forms in abandoned tunnels and shafts.

The so called California Onyx Marble is found in many beautiful varieties. The prevailing colors are various shades of orange on a delicate cream colored, and in some cases bluish ground. When cut and highly polished the chromatic effect is very striking. Large slabs cannot be obtained, owing to the nature of the deposit; and it is necessary to make up the surface required by piecing. It is coming into general use in California as an ornamental stone. It much resembles a mineral found in Mexico, and also misnamed "Mexican Onyx," of which magnificent specimens were shown at the Paris Exposition of 1878. California specimens, also exhibited, were small, but attracted much attention, their beauty and variety being the subject of remark by those who were specially interested in marbles.

The variety known as "Suisun Marble," and named from the locality at which it is found, received a share of notice and attention. A Californian at Paris stated, with evident pride, that he had seen a small slab at the Vatican, in Rome, in a collection of rare marbles, and that it was prized as being amongst the rarest and most beautiful of them all. The quarry from which this elegant ornamental stone is obtained lies in a low hill near the Town of Suisun, Solano County. The mineral has been somewhat extensively mined. No large pieces have been found of even texture suitable for working, which is a drawback to its usefulness, while that circumstance adds to its rarity and value. The deposit is evidently of aqueous origin. There are calcareous springs in the vicinity, which are now depositing tufa. Similar ones must have existed in former times of greater magnitude, which did stupendous work, and then, from some unknown cause, diminished to small and insignificant size. The varieties of this marble are so great as to be considered endless. The prevailing colors are red and yellow, in countless shades and tints. It is sometimes banded like agate, often showing stripes and bands of carnelian color, white and nearly black, like sardonyx.

The following analysis of Onyx Marble was made in the laboratory of the State Mining Bureau, by Edward Booth, in 1880:

Silica	.02
Ferric oxide	.07
Magnesia	.50
Lime	55.94
Carbonic acid	43.96
	100.49

Attempts have been made to burn it for lime, but probably with indifferent success, for it has been discontinued. Aragonite does not make good lime, owing to its property of falling to a powder when strongly heated.

Onyx Marble was known to the ancients; it was used in Rome and Carthage, and was known as Oriental Alabaster. The quarries were rediscovered in 1849, in Egypt, by M. Delmonte. It is now employed in Paris and elsewhere for ornamental works, such as bases for clocks, vases, etc.

The following localities are represented in the State Museum: (2.) Onyx Marble (red), Suisun. (261.) Onyx Marble (orange), Suisun. (556.) Onyx Marble (variegated), Suisun. (575.) Onyx Marble, San Luis Obispo. (1194.) From Gold Run, Placer County. (1872.) Deposited from a mineral spring—Soda Springs Hotel, Siskiyou County, near the falls, and near the Sacramento River. (2006.) Onyx Marble, southeast quarter section nine, township thirty-two south, range fifteen east, Mount Diablo meridian, similar to (575). Mr. J. Z. Davis has placed a mantel of this beautiful mineral in the Museum as a loan. The prevailing colors are orange and blue. It is not only a representation of one of the most beautiful ornamental stones in the State, but is a credit to the workmen who cut it. It is wholly a California production, and one of which the State may be proud. (2327.) Onyx Marble, deposited by a mineral spring six miles from Kernville, Kern County. (2740.) Aragonite, in beautiful snow-white crystals, found in the Candace Copper mine, Colusa County. (3602.) White Saccharoidal Aragonite, is easily reduced to a powder, and may perhaps be used as a substitute for chalk in chemical manufactories—it occurs in large quantities, deposit said to be four hundred feet thick—some attempts have been made to burn it for lime. (3733.) From Cerro Gordo, Inyo County. (4758.) From the ranch of J. M. Pugh, near Smithville, Colusa County. (5220.) Onyx Marble, near Yreka, Siskiyou County. A specimen of Yellow Aragonite was exhibited at the Paris Exposition of 1878 from Alpine County—it formed in a sluice box to the thickness of an inch—the impression of the grain of the wood was so perfect that the mineral looked on one surface like wood itself. It is a common thing for iron water-pipes laid in the Colorado desert to become choked by an accumulation of Aragonite. (2264) is a section of two-inch pipe which lay at Frink's Spring, on the Colorado desert, for two years—the pipe is nearly full—an analysis shows the mineral to be aragonite, with magnesia, sulphate of lime, oxide of iron, and silica as impurities.

A new locality of Onyx Marble has lately been found in Solano County, near Suisun, of which there is in the Museum a polished specimen. The following is from the San Luis Obispo Tribune of January 19, 1884:

ONYX.

The beautiful onyx found in San Luis Obispo County is a neglected jewel. Considerable of it has been mined and manufactured in San Francisco into ornaments, and although the material is as rich and elegant as anything conceivable, it is not yet fashionable. Governor Stanford has a very little in his house. The Chronicle office has a counter, and Captain Thompson, a millionaire resident of Alameda, has a fireplace, mantel, jamb, hearth, and other work of it, and these with a few offices in San Francisco, are about the extent of the use of onyx. The mantel in the Mining Bureau, of San Luis Obispo onyx, called the handsomest thing on exhibition, ought to draw attention to the substance. The objection is that it is a home product, and has not yet become fashionable. The newly rich people of San Francisco, and there are many of them, are not content with anything unless it has a foreign label on it. Their wine must have a French name, their marbles must be from Italy, and their ornaments such as the rich of the East have adopted as the fashion.

Onyx Marble is not only rare, but it is not apt to be found in large quantities in any one place. Owing to the peculiar manner in which it is liable to fracture, great care has to be observed in quarrying it. Powder cannot be employed for breaking it out; this has to be effected wholly by "wedging." And when quarried and furnished to the artist's hands care is still required in working it into shape, because of its fine texture. As it occurs in irregular masses, adhering to the inclosing rock, usually a sandstone, there remains generally a good deal of the latter attached to it when it is broken out. Seen as it comes from the quarry, this mineral has a rough, nodular appearance, suggesting the probability of its having been deposited by water holding lime in solution. From what has been said it will naturally be inferred that articles made from a mineral so scarce, so hard to quarry, and so difficult to shape, are somewhat expensive, and the inference is warranted by the prices these articles command the world over. A mantel-piece, for example, sells readily for $500, and other things in proportion. Such being the case, it is not to be expected that a mantel of this kind will be set up in every man's house, nor that our public fountains will just yet be chiseled out of this sort of material; nevertheless, now that we have this stone of such great excellence here in our own State, it may be expected that people of abundant means and cultured tastes will largely employ it for the adornment of their mansions, and the enrichment of their art treasures. Those who wish to see this new glory among California minerals can do so by visiting the State Mining Bureau, where it can be seen polished and wrought into elegant shapes, and also in its native roughness.

Aragonite has been found at the New Almaden mine, Santa Clara County (Dana).

Aragotite—see Petroleum.

Arenaceous Limestone—see Calcite.

10. ARGENTITE. Etym. "*Argentum*" (Latin name for silver). Silver Glance. Vitreous Silver. Sulphuret of Silver (Ag. S.)

Silver	87.1
Sulphur	12.9
	100.0

Color and streak, dark lead, gray, opaque; H.=2.25, sp. gr.=7.2—7.3; luster, metallic; B. B. on ch. melts easily, with strong smell of burning sulphur, yielding a globule of silver. It is a valuable but rather rare silver ore; it occurs in the ores of the Comstock Lode, in Nevada, and has been as yet found in but few localities in California, as follows: Minietta Belle mine, Inyo County; in veins, eight miles south of Benton, Mono County (Aaron); in the Kearsarge Mountains, near Independence, Inyo County, in cubical crystals (Aaron). It occurs in irregular amorphous masses, Oriental mine, Deep Spring Valley, at a depth of sixty feet from the surface No. (—). In testing this mineral with the blowpipe, it was found that on strongly heating a small fragment without flux, it formed a globule without immediately decomposing, but on allowing the globule to cool slowly by gradually diminishing the flame, and at length discontinuing it altogether, the dark colored globule became coated with dendritic crystals of metallic silver, which was a beautiful object when viewed under the microscope with a low power.

11. ARSENIC. Etym. *Arsenicum* (Latin). See also Arsenolite.

Arsenic, in a metallic or native state or condition, is found in Monterey County, at the Alisal mines, twenty-five miles from the Mission of San Carlos. (Blake.)

Arsenical Pyrites—see Arsenopyrite.

12. ARSENOLITE. Etym. "*Arsenicum*" (Latin).

Is an oxide of arsenic, having the following composition:

Arsenic	75.76
Oxygen	24.24
	100.00

It is identical with the white arsenic of commerce. The known localities are few. Blake gives as a locality the Amargosa mines in San Bernardino County, where it occurs in large masses.

Arsenolite is generally in stalactitic crusts, and it is doubtful if it has before been found in distinct crystals; when pure it has a specific gravity of 3.729. Cleveland, in his treatise on mineralogy and geology, published in 1816, makes the following significant remark: "When we consider the solubility of this oxide in water, and its effects on the stomachs of animals, we must recognize the goodness of the Creator in rendering it a rare mineral."

Crystals of arsenolite from the Exchequer mine, Alpine County, were shown at the Paris Exposition of 1878, changed from enargite. The manner of their formation is curious. Large quantities of the ore containing enargite had accumulated on the dump of the mine, which, undergoing chemical change, became hot; the miners describe it as having taken fire; fearing a loss, and not knowing the cause, they threw large quantities of water over the pile; when chemical action had ceased, beautiful crystals of arsenolite were found to have formed in the cavities of some of the largest masses of the ore. Some of the crystals were over half an inch in diameter, in perfect and modified octahedrons, having an adamantine luster, some transparent, while others were translucent or opaque.

13. ARSENOPYRITE. Etym. *Arsenic and Pyrite.*

Arsenopyrite or Mispickel is rather a common mineral in California, and is almost invariably associated with gold; sometimes the gold is contained in the mineral in surprising quantities, from which it can be recovered by roasting and subsequent treatment with acids. A portion of the gold is free and may be separated by simple crushing and vanning in water, or panning, as the operation is called in California. After roasting, if the mass is very slowly heated in a muffle with borax, the gold "sweats out" and appears on the surface in brilliant globules, while mispickel *per se* has no value except perhaps for the arsenic it contains, which could be easily recovered. As an associate and bearer of gold, it is a mineral to which attention should be given, and a few words as to the method of determining it will not be out of place.

Its luster is metallic, sometimes dull on the surfaces when long exposed to the elements; color, grayish white to almost silver white; quite brittle.

H=5.5 to 6, sp. gr. 6.3 to 6.4. It contains:

Arsenic	46.0
Sulphur	19.6
Iron	34.4
	100.0

It sometimes contains a little cobalt, rarely as much as 9 per cent; and sometimes nickel. When heated B. B., dense white fumes arise, which have the odor of onions or garlic. When fumes cease to be given off, the residue is attracted by the magnet. During the operation of roasting the charcoal is coated with white arsenious acid; in a closed tube B. B., a sublimate of sulphide of arsenic, of a deep red color, forms; and above it a black lustrous mirror of metallic arsenic. In an open tube the sublimates are those of sulphurous and arsenious acids; the former invisible but recognized by the smell, and the latter a white coating, which, under the microscope, is seen to be a collection of brilliant octahedral crystals. These experiments should be made with care and on small portions, for the fumes are poisonous.

The known localities of mispickel in California are numerous. The mineral is found in the gold mines in Grass Valley, at the Betsey mine, with gold (Blake); with blende and galena, near Auburn, Placer County; with tellurium and gold, North Fork claim, Forest City, Sierra County, discovered by accident in running a tunnel in a gravel claim, very rich in gold; in San Diego County, also rich in gold; in Inyo County, at several localities; Eureka mine, Calaveras County, with gold (Blake); and elsewhere in many of the gold mines of the State.

(4169) is Mispickel with gold, found near Georgetown, El Dorado County.

Asbestus—see Amphibole.

Asphaltum—see Petroleum.

14. ATACAMITE. Etym. "*Atacama*," a province in Bolivia.

Atacamite is chloride of copper, and a rare mineral. Dana gives the Inyo district, Inyo County, as a locality. I am very familiar with the country mentioned, and think the statement is a mistake—at all events, I have never seen it or heard of it in the State.

Aventurine—see Quartz.

15. AZURITE. Etym. *Azure, a blue color.* Mountain Blue, Blue Malachite, Chessy Copper, Azure Copper Ore, etc.

A hydrous carbonate of copper (2 Cu O CO_2+Cu O HO):

Oxide of copper	69.2
Carbonic acid	25.6
Water	5.2
	100.0

H. 3.5—4, sp. gr.—3.5—3.8. Luster, vitreous; color, azure blue; streak lighter; transparent; sub-transparent. In closed tube gives off water and turns black; dissolves in acids with effervescence. B. B. on ch. is reduced to metallic copper. When wet with hydrochloric acid the blowpipe flame is colored blue.

Azurite is a valuable ore of copper, easily reduced, and in a state suitable for the manufacture of sulphate of copper. When pure it is sometimes used as a pigment, under the name of Mountain Blue. It was known to the ancients under the name of Cæruleum Lapis Armenius. It is common in the Inyo Mountains, from White Mountain to Coso, but not as yet found in any considerable quantity. It occurs with cerusite, anglesite, and bindheimite, in the Modoc mine, Inyo County; also in Monterey County, and at Copperopolis, Calaveras County (Dana).

16. BARITE. Etym. "*Heavy*" (Greek), Barytes, Heavy Spar, Terra Ponderosa, Cawk, and many other names.

The element Barium is named from this mineral. The term *Terra Ponderosa* was applied by the earlier chemists and mineralogists from its unusual weight. It is a sulphate of Baryta, having when pure, the following composition:

Baryta	65.7
Sulphuric acid	34.3
	100.0

H. 2.5—3.5, sp. gr. 4.3—4.72. Luster vitreous, streak white, color from pure porcelain white to dark shades of blue, red, yellow, brown, and gray. Transparent, translucent, opaque; found amorphous and in crystals. It is insoluble in acids, but may be decomposed and rendered soluble by fusion with carbonate of soda, or caustic potash. The mineral is slightly soluble in water, 200,000 parts of water being required to dissolve one part of Barite. When heated B. B. on ch. it generally decrepitates and fuses into a globule. On continuing the heat it sinks into the coal; a portion of this being removed and placed on a clean silver coin and wet with water produces a black spot (sulphide of silver). Baryta is used in the arts as an adulterant for white lead and other paints; to give weight and body to paper; in the refining of beet sugar; in the manufacture of plate glass (carbonate); in pyrotechnics (nitrate); as a chemical reagent (chloride and carbonate); in medicine, and as a pigment under the name of permanent white, used as a water color; and in the manufacture of paper hangings. The element Barium was discovered in 1808 by Sir Humphrey Davy. In 1872 in England 4,650 tons of Sulphate of Baryta, and 4,442 tons of the carbonate were raised from the mines, having a value of £7,078. Barite is largely mined and prepared for market in Connecticut, in the vicinity of Stamford.

It occurs in small quantities at a number of localities in this State: With silver ores in the Calico mines, San Bernardino County (4167, 4234, 4735, 4953, 5027), milk white and honey yellow; with lead and copper ores, north arm of Indian Valley, Plumas County (Edman); with tetrahedrite, Irby Holt mine, Indian Valley, Plumas County; in the White Mountains, Inyo County; in a vein in the Alabama Range, Inyo County (Aaron); with gold, Malakoff hydraulic mine, North Bloomfield, Nevada County (4085); in the Morning Star mine, Alpine County, in the Satellite copper mine, Calaveras County, and elsewhere.

17. BERNARDINITE. Etym. *San Bernardino County, California.*

Is a resin found in the southern part of the State. The specimen in the State Museum (1460) was found near Santa Monica, Los Angeles County. The sample analyzed and described by J. M. Stillman, in the American Journal of Science and Arts, third series, volume 18, folio 57, was from San Bernardino County. Mr. Stillman, in a subsequent paper, in the same journal, third series, volume 20, folio 93, expresses the opinion that it is of recent vegetable origin. It is to be hoped that further information will be gathered concerning this substance.

18. BINDHEIMITE. Etym. "*Bindheim*," the chemist who first analyzed it.

Is a hydrous antimoniate of lead, or a compound of the oxides of the two metals; the antimony oxide acting as an acid, the lead as a base.

Oxide of antimony $Sb.\ O_5$	31.71
Oxide of lead $Pb.\ O.$	61.38
Water	6.46
	99.55

It is a rare mineral, resulting from the decomposition of other antimonial ores. The following California localities have been noted. The mineral has not been verified by analysis and there is some doubt as to its being really Bindheimite. Found in the Union mine, Cerro Gordo, Inyo County, and with Anglesite in the Modoc mine, Inyo County (1648).

19. BIOLITE. Etym. *Biot*, French physicist who first studied its crystallography. Hexagonal Mica. See also Mica.

It occurs near Grass Valley, Nevada County. Specimen in cabinet of C. W. Smith, Grass Valley (Blake).

BISMUTH—see Bismutite.

20. BISMUTITE. Etym. *Metal Bismuth.* Hydrous Carbonate of Bismuth, Stream Bismuth.

When pure it consists of:

Bismuth	90.00
Carbonic acid	6.56
Water	3.44
	100.00

H=4.—4.5, sp. gr.=6.8—6.9, dull, brittle, opaque, color yellowish to nearly white. This mineral is represented in the State Museum by a single specimen found in drift, while sluicing for gold, on Big Pine Creek, Inyo County (4641). A specimen exactly similar has been sent to the Museum from Phœnix, Arizona, found with gold in dry washing.

The metal Bismuth is white, hard, brittle, and easily fusible. H=2.25, sq. gr.=9.727 to 9.861, fuses at 283° F. It was first recognized as a distinct metal by Agricola in 1520, before which it was confounded with lead. It occurs mostly in a native state, but also combined with sulphur, carbonic acid, or oxygen, and mixes with other metals and minerals. On a large scale native Bismuth is separated from its gangue by gentle heat.

Neutral solutions of Bismuth have the remarkable property of being wholly precipitated by dilution with water; advantage is taken of this in the purification of the metal. Bismuth may be recognized by heating it B. B. on ch., when a characteristic yellow incrustation forms; the presence of lead, antimony, and other elements interfere with this reaction. The following is from the Manual of Determinative Mineralogy, by George J. Brush:

In the presence of lead and antimony Bismuth can be detected in the following manner: The mixture of the three oxides is added to an equal volume of sulphur and treated in a cavity upon charcoal with R. F.; the oxides are thus converted into sulphides. The assay is then placed upon a flat coal and treated with the R. F. and the O. F. until antimonial fumes have nearly ceased; the residue is placed in a mortar and pulverized and mixed with an equal volume of a mixture of one part of iodide of potassium and five of sulphur; it is then heated in an open glass tube and if Bismuth is present a distinct *red sublimate* of Iodide of Bismuth will be deposited a short distance above the yellow sublimate of lead; the sublimate of iodine, which is liable to be deposited higher up the tube, must not be confounded with the Bismuth sublimate.

This or the following test may be made: The pulverized substance is digested in hot nitric acid for some time, the liquid decanted and evaporated nearly to dryness, and poured drop by drop into a glass vessel of water; a white cloudy precipitate shows the presence of Bismuth.

Bismuth is used in the arts, in certain alloys, in medicine, as a cosmetic or face powder by women, as a pigment, etc.

TABLE OF USEFUL ALLOYS CONTAINING BISMUTH.

Name of Alloy.	Bismuth.	Copper.	Tin.	Antimony.	Lead.	Mercury.	Total.
1. Pewter	1.72	6.77	84.74	6.77	--------	--------	100
2. White metal for table bells	0.63	2.06	97.31	--------	--------	--------	100
3. Britannia metal	1.78	1.78	89.30	7.14	--------	--------	100
4. Amalgam for spherical mirrors	80.00	--------	--------	--------	--------	20.00	100
5. Queen's metal	8.34	--------	75.00	8.33	8.33	--------	100
6. Type metal and calico-printing blocks	16.66	--------	50.00	--------	33.34	--------	100
7. Fusible alloy, Newton's	50.00	--------	20.03	--------	29.97	--------	100
8. Fusible alloy, Rose's	50.00	--------	25.00	--------	25.00	--------	100

Alloys Nos. 7 and 8 fuse in boiling water. Spoons made of them melt while stirring a cup of hot tea. They serve a useful purpose in the mechanic arts. Fusible plugs made of an alloy containing bismuth are employed to prevent explosions in steam boilers; when the water is low the heat rises above the melting point of the alloy, which fusing, opens an orifice through which the steam escapes harmlessly. Bismuth is a high-priced metal, owing to its scarcity and the limited demand for it.

Bitumen—see Asphalt, under head of Petroleum.

Bituminous Shale—see Petroleum.

Black Jack—see Sphalerite.

Black Sands—see Magnetite.

Blende—see Sphalerite.

Bloodstone—see Quartz.

Blue Malachite—see Azurite.

Boracic Acid—see Sassolite.

21. BORATE OF STRONTIA.

Mentioned in letter written by Dr. John A. Veatch to the California Borax Company, quoted in full in the Third Annual Report, Part 2, Fol. 15.

22. BORAX. Etym. *Boorak*, or *Baurach* (Arabic), Bi-Borate of Soda, Tincal, Native Borax, etc.

Borax, crystallized, prismatic, equivalent to native borax. $NaO\ 2BO_3+10HO$=atomic weight, 191.

Boracic acid	36.65 per cent
Soda	16.23 per cent
Water	47.12 per cent
	100.00

Borax crystallized, octahedral. $NaO\ 2BO_3+5HO$=atomic weight, 146.

Boracic acid	47.94 per cent
Soda	21.23 per cent
Water	30.83 per cent
	100.00

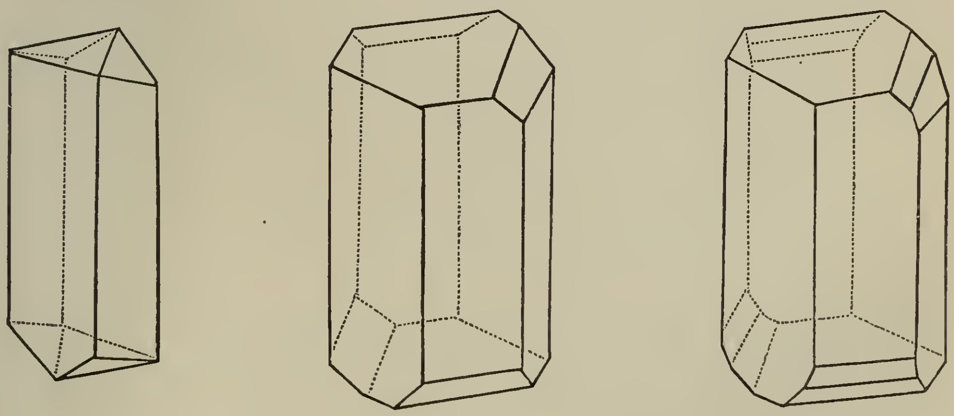
Borax, anhydrous. $NaO\ 2BO_3$=atomic weight, 101.

Soda	30.70 per cent
Boracic acid	69.30 per cent
	100.00

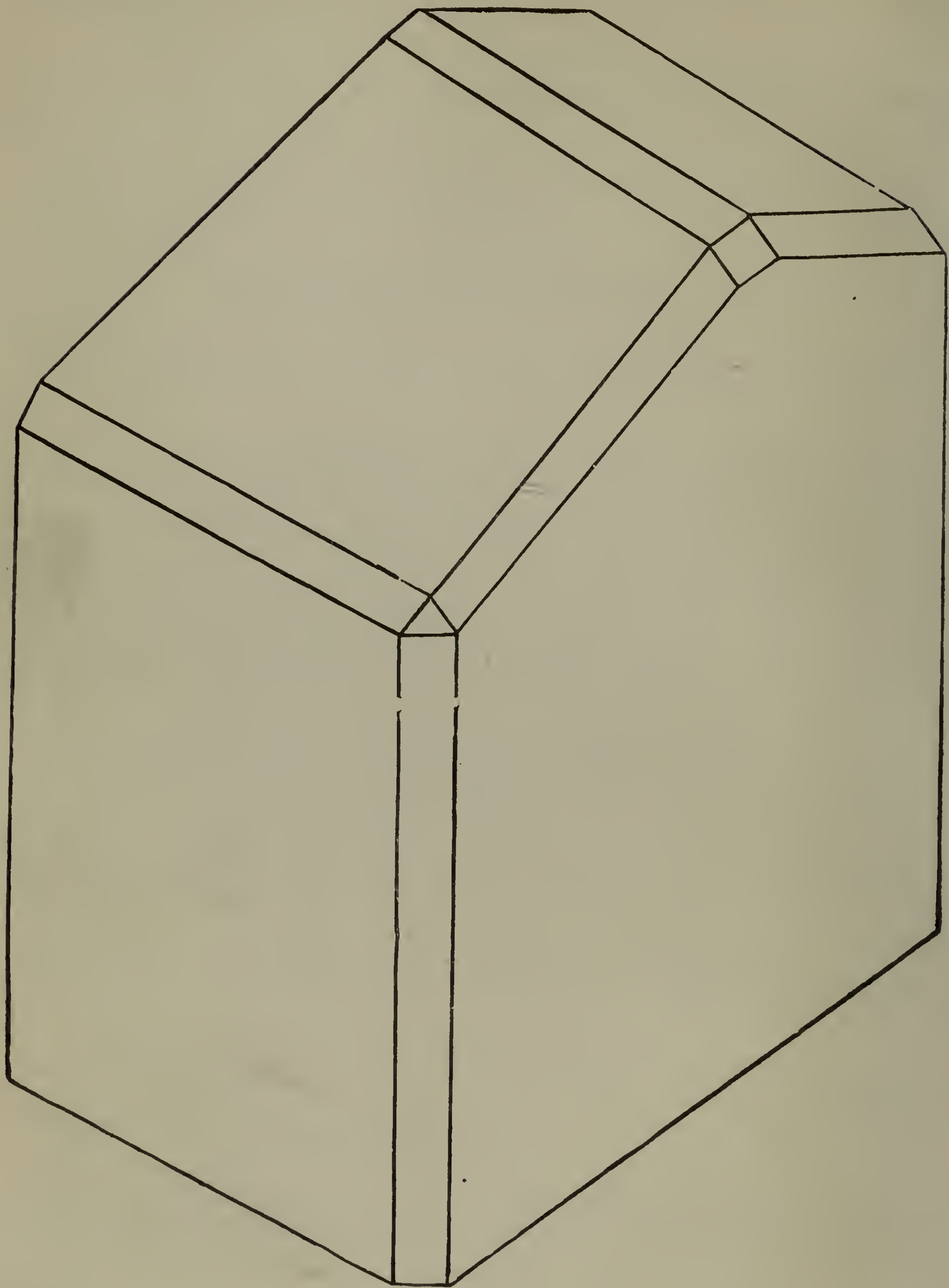
H=2.—2.5, sq. gr.=1.716. Borax has a sweetish taste and an alkaline reaction. It dissolves in twelve parts of cold water and in two parts of boiling water. At a low heat it melts in its water of its crystallization; if the heat be continued, it swells and becomes a white porous mass. At a red heat it fuses into a transparent fluid, which becomes, when cold, a transparent solid, resembling glass. Fused with fluorspar and bisulphate of potash, it colors the blowpipe flame distinctly green. Luster, vitreous; color, white, gray, brown, pinkish, greenish; generally translucent, sometimes transparent; brittle, streak white; phosphorescent if powdered in the dark.

The most beautiful transparent and perfect crystals form at the borax works in weak solutions, which have been allowed to stand for a considerable time undisturbed. The purest natural crystals are found on the property of the San Bernardino Borax Company, which are shoveled into the dissolving tanks by the ton. They differ from the celebrated crystals from Borax Lake, Lake County, in being transparent and inclosing fluid in large cavities.

The following figures of prismatic borax crystals are from *Hauy's Traité de Mineralogie:*



Crystal of Native Borax from Borax Lake. Natural size.



The early history of borax is vague and uncertain. The statement by some writers that the substance was known to the ancients, lacks confirmation. There is but little reason to believe that *chrysocolla*, literally, *gold glue*, was borax. Pliny's description shows it to have been of an entirely different nature. The name *chrysocolla* was given to borax by Agricola (*de re metallica*) because it was used in soldering gold. Agricola was a celebrated metallurgist who lived in the first part of the sixteenth century. One author (Parke's Chemical Essays, London, 1830,) quotes from the writings (*Vita Caligulæ*) of Suetonius, who lived in the first century, that "the circus in his time was covered with vermilion and borax." The first borax known in Europe came from the East.

In 1732, Stephen Francis Geoffroy, a celebrated chemist, made the first analysis of borax, and was the first to notice the green flame imparted to burning alcohol by free boracic acid.

In 1748, Baron announced the discovery that borax was sedative salt and soda.

In 1772, the first authentic accounts were received in Europe as to the borax lakes of Thibet. According to Turner, "these lakes lie a few days' journey from Tezhoo Lomboo. The borax is found in masses in the mud at the bottom, beneath the stagnant water, with salt and alkali. Blanc and Pater Rovato say that these lakes lie among the mountains. The most noted (called *Necbal*) is located in the Canton of Sumbul. The water is conveyed in sluices, in which salt crystallizes. The liquor containing the borax is conducted to evaporating basins, in which the borax crystallizes out. It is impure, and has the form of six-sided crystals, sometimes colorless, at others, yellowish or green; always covered with an earthy incrustation, fatty to the touch, and with a soapy smell." Another account informs us that "the borax is dug from the margin of the lake. The crystals removed are replaced by others after the lapse of a certain time."

Simple tests serve to detect the usual foreign substances contained in borax, natural or artificial. When pure it should dissolve in twelve to twenty-four parts of cold water to a clear solution without color or residue. A sample heated to fusion should leave a residue weighing fifty-three per cent, nearly. If adulterated with nitrate of potash it will deflagrate when thrown on burning coals. If alum is present as an impurity, its solution will react acid to litmus paper. Artificial borax is often degraded by admixture of phosphate of soda, sometimes to the extent of twenty per cent, in which case its solution will give a yellow precipitate upon addition of molybdate of ammonia mixed with excess of nitric acid. Lime is indicated by a white precipitate, which falls when carbonate of soda is added to the solution. This precipitate dissolves in dilute hydrochloric acid with effervescence. Sulphate of soda and chloride of sodium (common salt), the natural impurities, are indicated, the former by a precipitate with chloride of barium in the presence of free acid, and the latter by the formation of a white curdy precipitate with nitrate of silver in the presence of free nitric acid. The latter precipitate is soluble in ammonia, and is reproduced on the addition of an acid.

If to a solution of boracic acid, or an alkaline borate, hydrochloric acid is added to slight acid reaction, and a slip of turmeric paper half dipped into it and dried on a watch-glass at 212° Fahrenheit, the dipped portion shows a peculiar red tint; this reaction, which is delicate, must not be confounded with similar colors obtained from other substances; to avoid which, experiments should be made with pure solutions, carefully prepared, to educate the eye.

Borax may be determined volumetrically. For this assay a solution of sulphuric acid must be prepared, in which an exact chemical equivalent of the acid shall be contained in each litre. This acid solution, called "normal sulphuric acid," must be carefully preserved in a well stoppered bottle, as on its purity and uniform strength depend the accuracy of the results. An equivalent of the borax to be assayed (or rather what would be an equivalent if it were pure) must then be dissolved in distilled water.

Now if both solutions contain exact equivalents, they would neutralize each other if poured together. In a like manner, if a tenth of each solution were mixed they would neutralize each other. The tenth of a litre is a convenient measure for the assay, because it contains 100 cubic centimeters (C.C). If 100 C.C. of the acid solution neutralized the tenth of an equivalent of borax in solution, it would be evident that the sample was pure. If 80 C.C. only were required, the sample contains eighty per cent of borax. In other words, each C.C. of the acid solution represents one per cent of crystallized borax in the sample.

When litmus is added to a solution of borax, only a purple red color is seen while any borax remains undecomposed; but, upon adding sulphuric acid, at the instant that the last atom of soda is changed to sulphate, a light red color appears.

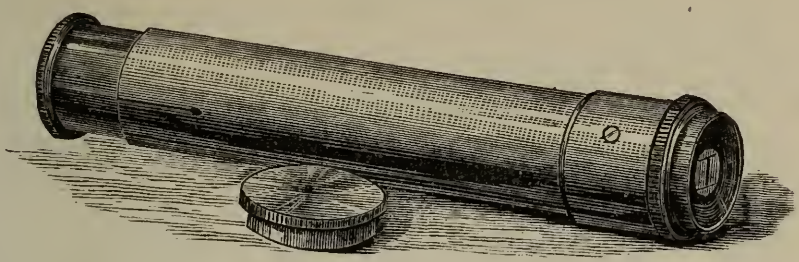
Upon these reactions, the volumetric assay is based.

It has been shown elsewhere, that the chemical equivalent of crystallized prismatic borax is 191. One tenth of this weight—19.1 grammes of the borax—is dissolved by shaking in cold water: 250 to 300 cubic centimeters will be required. The solution must not be filtered.

This solution is placed in a clean beaker, solution of litmus added until a deep color is imparted to the fluid. Normal sulphuric acid is then dropped in from a burette, graduated to cubic centimeters and tenths, until the color suddenly changes to a bright red. The first test may be made somewhat carelessly, as it will only be an approximation. The beaker is then washed out, and the operation repeated; this time with greater care. The result will be nearly correct. A third experiment will serve to verify the result. The reader should refer to some practical work on chemistry for description of the apparatus and method of making the test solutions. *Sutton's Systematic Handbook of Volumetric Analysis*, third edition, is one of the best.

Only borax can be estimated by this method. The determination of boracic acid in minerals and other substances, is extremely difficult, and can hardly be explained without an elaborate description, which may be found in text-books on analytical chemistry. In the volumetric method described above it is customary to deduct 0.5 C.C., to correct for the excess of sulphuric acid required to develop the red color in the assay.

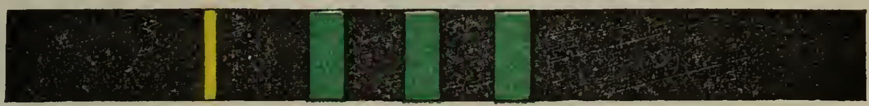
Boracic acid is soluble in 27 times its weight of water at 60°, and in 2.96 parts of water at 212°. The hydrated acid dissolves in alcohol, which burns with a characteristic green flame, seen even in the presence of soda salts, which impart a yellow color to the flame. But, if soda is largely in excess, the green color is masked, and can only be observed when the alcohol is nearly consumed, and the distinguishing color is more marked if the expiring flame is gently agitated by breathing upon it, but, under these circumstances, a good eye is required to distinguish the color. By far the best color test is made by the use of the direct vision spectroscope, which shows three distinct pale green bands in the green part of the spectrum. I have used the beautiful little instrument made by Browning, of London, and which is shown in the figure:



The use of this instrument is simple, and once seen is easily understood and practiced. The substance supposed to contain boracic acid or a borate is placed in an evaporating dish, and a few drops of sulphuric acid added. A brisk effervescence generally takes place. The contents of the dish must be stirred, which may be done with a small stick, or anything convenient at hand. Alcohol is then poured in, in small quantity, and ignited. All that is then required to determine the presence of borax or boracic acid is to look at the flame through the spectroscope. Three distinct and beautifully green bands will be seen, if boracic acid is present.

If *free* boracic acid is contained in the sample, the green bands may be produced without the introduction of sulphuric acid. It is best, however, always to use the acid, which decomposes the salt containing the weaker boracic acid, and to make a secondary test to prove the boracic acid to be free or otherwise.

The experiment should be made in a dark room. The bands are best seen when the slit is so far closed as to show the yellow sodium band, always present, as a very narrow line.



With the spectroscope, a bottle of strong sulphuric acid, one of alcohol, and a small evaporating dish, the prospector, although unskilled in chemical handicraft, may detect with unerring certainty the presence or otherwise of boracic acid, or any of its salts, in the deposits he may find.

When boracic acid is suspected in steam issuing from hot springs, it is only necessary to condense a portion of the steam. The resulting water is evaporated nearly to dryness at a *very gentle* heat. Alcohol is then added, and the flame examined as before. This test shows the presence of boracic acid in the waters of Mono Lake, and in the eruptive mud from the mud volcanoes of the Colorado Desert, San Diego County.

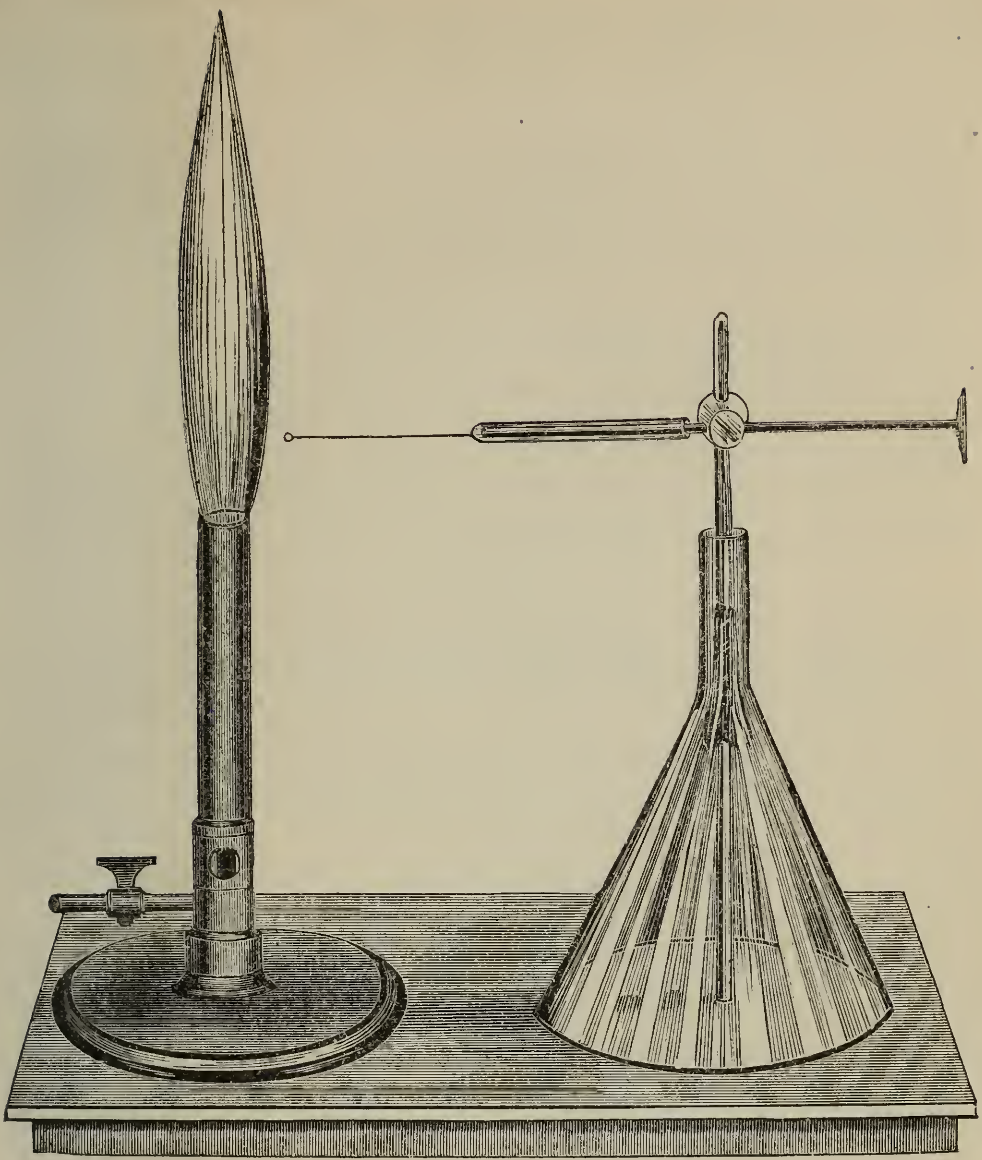
The only weak point in this determination lies in its extreme delicacy. In inexperienced hands it might lead to the hope that the sample was rich when boracic acid was present only in small quantities; but a little experience will correct this, for it will be seen that when the quantity is small the bands are faint, and come and go in an intermittent manner; while, if the quantity is large, they are distinct and well defined, and the color a clear green. As with the sodium band, the intensity of the color is an index to quantity—all of which may be learned by experience. In making this determination all bands of other substances present, as lithium, potassium, etc., must be disregarded.

In prospecting the deserts, there are no facilities for chemical operations, and the prospector, generally poor, can but ill afford to send his samples to San Francisco, or pay the cost of chemical analysis. These considerations have, no doubt, retarded the development of the borax interests of the State.

It is sometimes inconvenient to use alcohol in the manner described. The experiment can be made with equal facility in the flame of a Bunsen gas burner, or spirit lamp.

The substance to be examined is supported in a loop of platinum wire. The wire may be held in the hand when the color is to be observed by the unassisted eye; but when the spectroscope is used it must be supported. A convenient support may be improvised in the following manner: A small glass funnel is placed on the table, with the tube part upwards. A glass rod or wire, small enough to pass easily into the tube, is cut to a convenient length, wrapped with paper, and pushed into the tube of the funnel. The paper acts as packing, and when arranged the rod may be raised or depressed by pushing up or down in the tube. A common cork, of medium size, is pierced with a cork borer diametrically, and placed on the rod. A wire is thrust through the cork at right angles with the vertical rod. This wire may be three or four inches in length.

A small glass tube may then be selected, and cut to the length of an inch and a half. One end is closed in the blowpipe flame, and a short piece of platinum wire inserted while the glass is still hot; when cold the wire will be firmly set in the closed end of the tube; the other is open. In the end of the platinum wire a small loop is made; when all is ready the substance is ground in an agate mortar with a small excess of a mixture of equal parts of bisulphate of potash and fluorspar. The platinum wire is first held in the flame for a moment to see that it is clean and gives no color. The flame is examined to be sure that no color is imparted by any uncleanness of the burner. If the flame is blue, and perfectly non-luminous, it may be observed through the spectroscope, and if no color is seen except the bright yellow sodium band the apparatus is ready for use. To make the experiment, the Bunsen burner is lighted, and a full head of gas turned on, making the flame five or six inches long. The glass tube with its platinum wire and loop is slipped off from the horizontal wire, and the loop dipped into a small vessel of distilled water, and then into the mixture in the agate mortar. The tube is then replaced on the wire, and the whole stand pushed near the flame with the loop and the assay about half an inch above the top of the burner. The spectroscope is then held to the eye in the left hand, while the stand is gently pushed with the right until the substance to be examined touches the flame. The green bands will instantly appear if boracic acid is present. This description will be fully understood by a glance at the following engraving:



Apparatus for observing the green color of burning boracic acid, scale ½.

Bisulphate of potash is prepared by placing a convenient quantity of powdered sulphate of potash in a porcelain capsule and wetting it with concentrated sulphuric acid. The mixture must be heated until no more white fumes are given off, and a small portion taken out on a glass rod cools into a hard coating. The heat employed must be sufficiently great to keep the mixture in a state of fusion until the excess of acid is driven off. When cold, the mass must be pulverized and kept in a glass-stoppered bottle for use.

USES OF BORAX AND BORACIC ACID.

The consumption of boracic acid and its salts is only limited by the supply. It is very largely used in the manufacture of pottery and earthenware as a glaze. In 1820, Mr. Wood, of Liverpool, applied boracic acid to the glazing of pottery, which has continued, with increasing consumption, to the present time.

The following mixtures are published. For common English porcelain:

Feldspar	45 parts
Silica	9 parts
Borax	21 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	111 parts

For figures and ornaments:

Feldspar	45 parts
Silica	12 parts
Borax	15 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	108 parts

The glaze is made by melting the ingredients together, and afterwards grinding them with water, into which the ware is dipped and dried. The articles are first partially burned, in which form they are called "biscuit."

Large quantities of borax are consumed in the potteries at Trenton, New Jersey; East Liverpool, Ohio; Philadelphia, and Cincinnati, and will eventually be used in prospective potteries in our own State.

Borax has lately been extensively applied to the manufacture of porcelain-coated ironware, known as "graniteware."

Boracic acid is used in the manufacture of certain varieties of glass and in "*strass*," which is the base of artificial gems named after the inventor, Strass of Strasburg, who lived in the seventeenth century, and who was the first to make artificial gems of this character.

The following is the composition of strass:

Pure silex	300 parts
Potash	96 parts
Borax	27 parts
White lead	514 parts
Arsenic	1 part
	938 parts

All the ingredients must be pure, especially the borax, which must be prepared from pure boracic acid. Tincal is not suitable.

The mixture is put into a Hessian crucible, and kept at the highest heat of a pottery furnace for twenty-four hours. The longer it is kept in a state of fusion the clearer and more homogeneous it will be when cooled. It is used by lapidaries for imitating diamond, topaz, and other white gems. For colored gems various metallic oxides are added in proportions only learned by experience. The coloring matter must be in the finest powder, and not only very intimately mixed, but the mixture must be very strongly heated, the heat must be long continued, and the cooling gradual.

It is stated in Parke's Chemical Essays that four ounces of borax and one ounce of pure fine white sand will make a pure glass, so hard as to cut common glass like the diamond.

The following formula is given of the brilliant greenish yellow glass of Sevres:

Silica	19.32
Protoxide of lead	57.64
Soda	3.08
Boracic acid	7.00
Protoxide of iron	6.12
Oxide of zinc	2.99
Antimonic acid	3.41
Potash	.44
	100.00

Vitrifiable pigments for glass staining and encaustic tiles are rendered fusible by admixture of borax. The following formulæ are given:

1. One part sand, three parts litharge, one third part borax. The borax must be fused in a platinum crucible and poured into water, and, when cold, ground fine.

2. One part sand, two and three quarters parts litharge, three eighths parts borax.

3. One part sand, two parts litharge, one fourth part borax.

4. One part sand, three parts minium, one eighth part borax.

5. Six parts white sand, washed, and heated to redness, four parts yellow oxide of lead, one part borax glass, one part saltpeter.

6. One part sand, two parts litharge, three quarters parts borax glass.

7. Eight parts white quartz sand, washed and calcined, four parts borax glass, one part saltpeter, one part white chalk.

All prepared as in No. 1.

In the art of enameling, borax is also largely used as a flux.

Borax has the property of dissolving the metallic oxides, which makes it useful in soldering metals. It renders the surfaces to be joined, clean, so that the solder "runs" and fills the joint between them. For this purpose, as well as in welding iron, the octahedral is the most desired, as, containing less water, it sooner settles down quietly on the work. In soldering small articles, the borax is rubbed on a slab of slate, with water, and the mixture put on with a camel's hair brush.

The same property is taken advantage of in blowpipe chemistry, to determine the presence of certain metals which may be in the substance under examination. A loop is prepared on the end of a thin platinum wire, in which borax is melted in the blowpipe flame; a small quantity of the substance in a fine powder is then introduced by wetting the borax bead and touching it to the powder. The bead is again subjected to the flame; first in the outer, and then in the inner flame, and allowed to cool while being closely observed.

BLOWPIPE REACTIONS.

	Outer Flame.		Inner Flame.	
	Hot.	Cold.	Hot.	Cold.
Yellow	Vanadic acid. Sesqui-oxide of iron. Oxide of lead. Ter-oxide of bismuth and of antimony.		Tungstic, titantic, vanadic, and molybdic acids.	
Red	Oxide of chromium. Sesqui-oxide of cerium.	Oxide of nickel.		Oxide of copper.
Violet	Sesqui-oxide of manganese. Oxide of cobalt containing manganese.			
Blue	Oxide of cobalt.	Oxide of cobalt. Oxide of copper.	Oxide of cobalt.	Oxide of cobalt.
Green	Oxide of copper.	Sesqui - oxide of chromium.	Sesqui-oxides of iron, chromium, and uranium.	Vanadic acid. Sesqui - oxides of iron, chromium, and uranium.

Borax has great detersive properties and is very useful in the laundry. The washerwomen of Holland and Belgium, so celebrated for their fine and white linen, have used borax as a washing powder for many years. They add borax in the proportion of half a pound to ten gallons of boiling water. For washing laces, cambrics, and even woolen blankets and other goods, it will be found very useful. It is also a valuable cosmetic, rendering the skin soft, and it is claimed it will prove a preventive and even a cure for certain skin diseases. It is an excellent shampoo, without any admixture except water, and is perfectly harmless. For cleaning brush and comb it will be found very useful. It is so essential to the toilet that a bottle of it should be kept always ready, prepared as follows:

A quantity of refined borax is shaken up in a bottle with water until no more will dissolve. The solution is then poured off into a clean bottle and half the quantity of water added, and both mixed by shaking. If not clear it must be left some time to stand and the clear portion poured off, or, better still, filtered through paper. In this condition it may be added to a basin of water, used as a mouth wash, and other ways as described.

In medicine, according to the United States Dispensatory, borax is a mild refrigerant and diuretic. It is a remedy for nephritic and calculus complaints dependent on an excess of uric acid. Externally it is used in solution as a wash in scaly eruptions, and for other diseases.

Borax and boracic acid are used to render cream of tartar more soluble. The formula given in the French codex is as follows:

Four hundred parts cream of tartar, and 100 parts of boracic acid are dissolved in a silver basin with 2400 parts of water at a boiling heat. The solution is kept boiling until nearly all the water is evaporated. The heat is then moderated and the mixture stirred. When it has become very thick it is removed in portions, which are flattened in the hand, well pounded, and powdered. This is soluble cream of tartar.

A solution of borax is used as a gargle for sore throat and in colds, and it has been found effective in cases of epizooty in horses. In 1873 experiments were made in San Francisco which gave favorable results. The doses were four ounces daily, given pulverized in the food.

In 1878 Smith Bros. sold 20,000 pounds of borax to Chicago consumers, to be used in preserving and canning beef.

Borax is used as a mordant in calico printing and in dyeing, and as a substitute for soap in dissolving gum out of silk; in solution as a wood preservative, and in the manufacture of soap. A varnish made by boiling one part of borax with five parts of shellac is used in stiffening hats. With caseine borax forms a substance which is used as a substitute for gum. A solution of borax in water may be mixed with linseed oil and used for cheap painting.

Borax is extensively used in assaying, in the metallurgy of ores, and in the smelting of copper, and it is said to be an excellent insecticide, being especially obnoxious to cockroaches.

There are probably other uses to which it has been put, and no doubt new applications will be found for it if the production should increase.

Borax was first discovered in California in the waters of Tuscan Springs, in Tehama County, January 8, 1856. The water was brought to San Francisco by Dr. Trask, State Geologist, and the analysis made by L. Lanszweert. The crystals then obtained were sent to the Museum of the California Academy of Science. Borax Lake was discovered by Dr. John A. Veatch, in September, 1856. This deposit was worked from 1864 to 1868, during which time it produced 1,181,365 pounds of borax. Borax fields were discovered in San Bernardino County, February 14, 1873. These deposits have been worked by the San Bernardino Borax Mining Company, who have produced very large quantities of borax. This valuable mineral has since been found at a number of localities in the State: In Death Valley, Inyo County, in 1873; and Borate of Lime (ulexite) was discovered at Desert Springs, called also Cane Springs, in Kern County, February 15, 1873, from whence a considerable quantity has been extracted. The dry lake in which the borates are found is situated in Township 30 south, Range 38 east, Mt. Diablo base and meridian. Borax and Borates have been found in considerable quantities in San Bernardino County, near Calico, which deposit is at the present time being worked.

PRODUCTION OF BORAX IN CALIFORNIA.

In the third annual report of this office, folios 78, 79, the total production of borax in California and Nevada was given, and for California as follows: From discovery in January, 1856, to June 1, 1883, 17,857,986 pounds. The yield of California from June 1, 1883, to January 1, 1884, is estimated by Mr. S. Riddell at 1,866 tons, of 2,000 pounds each, or 3,732,000 pounds.

The receipts at San Francisco, Mohave, and Sacramento, from January 1 to April 30, 1884, inclusive, were 1,522,300 pounds, all of which was produced by California.

Received at San Francisco	1,289,500 pounds
Received at Mohave	190,000 pounds
Received at Sacramento	42,800 pounds
	1,522,300 pounds

To June 1, 1883	17,857,986 pounds
To January 1, 1884	3,732,000 pounds
To April 30, 1884	1,522,300 pounds
Total yield	23,112,286 pounds

It is necessary now to speak only of the progress made since the publication of the last report by this industry, its present condition, and the outlook for it on this coast in the future. Although the discovery of this salt, made during the past year in the eastern part of the Calico district, San Bernardino County, led to a good deal of prospecting for other deposits in that part of the State, the movement subsided before the Summer was over, without noteworthy results; though, as usual, numerous additional finds were reported, none of which have, however, since met with confirmation; nor is this matter for serious regret, the want of the home producer resting just now, not so much in the discovery of new deposits of the crude material, as in improved prices for the manufactured product.

The several companies previously in the field have, during the twelve months under review, continued work, no others having since been formed, or at least commenced active operations. Our exports to foreign countries consisted of 1,238,407 pounds to Liverpool; 20,231 pounds to China; 8,882 pounds to Japan; and 6,301 pounds to Mexico, with smaller lots each to Australia, British Columbia, and the Hawaiian Islands. At the opening of 1883 refined borax was selling in New York at 13 cents per pound, but soon fell to 10 cents. After the enactment of the new tariff law the price there advanced to 15 cents, but finally dropped to 9, the rate now ruling in that market, this being for carload lots. The price of borax in San Francisco is less the price in New York by cost of transportation—say 1¼ cents per pound. The present low price of this commodity is due to heavy deposits of the crude article having been discovered, not only in California and Nevada, but in other parts of the world; the latest find of this kind reported being on the eastern side of the Andes in the States of La Plata, where the borate of lime is said to occur in large quantities and of excellent grade. Some considerable lots of this material, shipped via Rosario to Liverpool and Hamburg, met with ready sale on account of its richness. While the Tincal trade of India has been active and the manufacture in Italy of boracic acid has undergone some increment, exportations of the crude material from the west coast of South America have been quite free of late. Add the large production made in California and Nevada, and the causes for so great decline in the prices of borax become amply apparent. Whether the market is to undergo early improvement will probably depend on new and large uses being found for this salt, or on manufacturers being able to effect some arrangement looking to a restricted production.

The wisdom of protecting this industry against a crushing foreign competition, becomes manifest, on comparing the prices our people now pay for borax with those that obtained twenty years ago, before any home production of this salt was made. Accepting the Druggists' Circular as authority, the New York price of borax in the year 1864 was thirty-five cents per pound; a figure we would probably still have to pay for it but for these competing sources of supply opened up in California and Nevada, which to date have furnished the markets of the world forty-five million pounds of commercial borax. Besides retaining in the country large sums of money that would otherwise have been spent abroad in the purchase of this article, this business has been a great help to many other industries; populating districts that but for its presence would have long remained uninhabited. This class of our salines occupy desert regions, far inland, and, for the most part, remote from shipping points, either by sea or rail. They have, therefore, to be worked under many disadvantages; labor as well as supplies being dear in these isolated and wilderness lands.

The following abbreviated statement of the expenditures made by one of our large borax companies for labor and supplies, illustrates how heavily they are taxed on account of these items:

Class of Employés.	Per day.
Blacksmith (first)	$5 00
Blacksmith (helper)	3 00
Engineers	4 00
Teamsters	3 25
Coopers	3 25
Boilermen	2 31
Watchmen	2 31
Laborers	1 25

The wages of clerks, agents, foreman, etc., ranging from $100 to $125 per month; cooks, $50 per month. These are the wages paid white men, who are all boarded and lodged at the company's expense. Chinamen, a few of whom are employed by some of the companies, receive $1 25 per day, boarding themselves. The money paid out for wages by these borax companies ranges from $1,500 to $3,300 per month. For forage, the sums paid out monthly vary from $300 to $600; the cost of other supplies being proportionately high.

As the companies now making borax on this coast are realizing but little if any profits, we need look for no immediate increase of production here, but rather a falling off, unless some of the contingencies hinted at should arise, or other favoring conditions supervene.

23. BORNITE. Etym. *Born*, a chemist of the last century. Purple Copper Ore, Variegated Copper, Horseflesh Ore, Erubescite, etc.

Is a double sulphide of copper and iron. The elements vary in different specimens. The following is the analysis of an average sample:

Copper	58.20
Iron	14.85
Sulphur	26.98
	100.03

Luster, metallic; color, red to purple, rather bronze color. H. 3, sp. gr. 4.4.—5.5. B. B. on ch. fuses to a magnetic globule, with soda gives a globule of copper which is malleable. Bornite is quite common with other ores of copper, especially Chalcopyrite. It is found in California at Light's Cañon, Plumas County, and in the Siegel Lode, Plumas County (Blake); Kings River, Fresno County; with Chalcopyrite and pyrite at Copper City, Shasta County (804); near Lexington, Santa Clara County; Genesee Valley, Plumas County (Edman); at Copperopolis and Campo Seco, Calaveras County; and at numerous localities in the Inyo Mountains, Inyo County.

Bronzite—see Enstatite.

24. BUILDING STONES.

When in the course of events a city springs up in a new locality, stimulated by circumstances into a rapid growth, it is found necessary to utilize convenient materials, generally wood, in the construction of buildings for temporary but immediate use. We are led to believe that wood was extensively used in building ancient cities, which were afterwards rebuilt, first of brick, and then of marble and similar stones. We find it stated by Strabo (book 5, chapter 11, 5), that in his day the "wood of Tyrrhenia was mostly employed for building houses in Rome and in the country villas of the Romans, which resemble in their gorgeousness Persian palaces." A similar experience was made in Chicago, and notably in San Francisco. Wooden buildings have here served their purpose, and are now falling rapidly into a condition of decay. Nearly the whole city must, within a comparatively few years, be rebuilt. The short-lived wooden buildings must and will be replaced by those of a better and more durable character. Even should it be desired to replace them in kind, the forests do not exist to supply the lumber. Great injury has already been done to the State by the depletion of the forests. This cannot continue. While there is and will be lumber sufficient for economical use for many years, still the time has come when other materials must be sought to supplant lumber. Sufficient investigation has been made to show that building stones of excellent quality are abundant in California. The great mass of the earth's crust is composed of seven principal minerals, estimated at nineteen twentieths, as follows:

1. Quartz.
2. Talc or Steatite.
3. Serpentine.
4. Hornblende and Augite (varieties of Pyroxene).
5. Feldspar.
6. Mica.
7. Carbonate of Lime.

When two or more minerals are mechanically mixed they form rocks. Some minerals occur in such large masses that they are classed as rocks, as for example limestones, quartz, ice, etc. The crystalline rocks, granite, and gneiss are complex and contain nearly all the elements which enter into the composition of the plutonic, volcanic, and sedimentary rocks. They disintegrate to sand, kaolin, and alkalies, which form new combinations in soils and minerals. Sandstones, slates, mica-schists, and argillaceous rocks are built up of the ruins of the older crystalline rocks. The study of the rocks is deeply interesting, but lithology must be considered as yet in its infancy. The State Museum contains many specimens of rocks from California and other Pacific States and Europe, with a considerable number of thin sections prepared for microscopic observation. These collections include many valuable building stones. There is a full set of the rocks cut through by the Sutro Tunnel in Nevada, which constitutes a complete section of that great work.

In a State like California, in which numerous chains of mountains cover a large area, building stones abound. It is only necessary to study them and select those most suitable and accessible, and turn them to account. The requirements of building stones vary with the uses to which they are to be put, but the following are the most important desiderata:

First—*Durability.* Resistance to the action of the elements, especially water. Power of resisting the action of fire in the event of a conflagration.

Second—*Beauty.*

Third—*Ease with which they can be cut into suitable shapes.*

Fourth—*Cost of transportation from the quarry.*

It is a great mistake to suppose that the hardest stones are the most durable, or that any stone is indestructible. Climate has much to do with the durability of stone. Obelisks that scarcely showed the attacks of time in the dry climate of Egypt, when removed to Rome, Paris, London, or New York, soon exhibit signs of decay. Edward Clarke, who traveled extensively in Europe, Asia, and Africa, commencing in the year 1800, gives in his published travels much information concerning the durability of building stone. In the Troas he noticed "granite columns lying about, whose surface exhibited a very advanced state of decomposition, * * * serving to confirm a fact of some importance, namely, that the durability of substances employed for purposes of sculpture and architecture is not proportioned to their hardness." He noticed also at Alexandria that the fallen obelisk was considerably decomposed on the exposed surfaces, while on the buried face the hieroglyphics were as perfect as ever. He formed the opinion from his large experience and observation, that Parian marble was the best and most enduring of stones used in ancient sculpture and architecture. Baked bricks and terra cotta were found to be still more durable.

The cathedral at Cologne, partly built in the middle of the thirteenth century, of Bunter sandstone, shows serious indications of decay. The Jurassic limestones of France are soft, easily worked, and very durable. The Tertiary limestones, of which Paris is largely built, are of a similar character. Many buildings in the City of Rome are built of Travertine, a straw-colored tufaceous limestone, deposited by water. The Colosseum, St. Peters, Castle of St. Angelo, the Quirinal, and other noted buildings, are of this stone, which is so soft when first quarried that it can be cut with saws into blocks. At a meeting of the New York Academy of Sciences, January 29, 1883, Dr. Alexis A. Julien read a paper on the decay of building stones of the City of New York. Of 100,193 buildings in New York, 11.6 per cent only are of stone; of this number, 78.6 per cent are of brown sandstone, and 7.9 per cent marble. The soft building stones show considerable decay in five years, those that last twenty or thirty years are considered exceptional. Granites within fifty years begin to decay. Numerous plans have been suggested to stay the progress of the decay, as application of coal tar, paint, oil, soap and alum solution, paraffine, beeswax, rosin, tallow, etc., dissolved in naphtha, turpentine, camphene, and oil; none of these have proved to be more than temporarily effective. His investigations show that all the building stones used in New York show the effect of the climate within a few years, and that some of them fall rapidly into a state of decay. The Ohio sandstone was found to be the most durable of all the stones used, and gneiss the next. French oolite lasts only from twenty to forty years. The climate of San Francisco is such that building stones would last much longer than in New York. It is an important consideration to select for our cities in California the best building stone obtainable, and to profit by the experience made in other countries. San Francisco is destined to become a second Rome. In a few centuries, if it meets with no serious setback, it will be the largest city in the world, at least that is my opinion. We have made serious mistakes in laying out its streets and planning its system of drainage. Let us compensate in a measure by rebuilding it of durable materials, selected with judgment, prudence, and care.

The rocks usually employed in building are:

Granite,
Syenite,
Porphyry,
Freestone, or Sandstone,
Diorite, or Greenstone,
Lavas, including Basalt and Trachyte,
Limestones, including Marble, Tufa, Dolomite, Slate, Serpentine, etc.

All these are found in the State. Some of them are abundant.

The materials for artificial stones, concretes, cements, brick, terra cotta, etc., are also found here; therefore there is no excuse for the construction of cheap and ephemeral buildings in our cities.

Granite is a compound acidic rock, composed of three minerals, Quartz, Feldspar, and Mica, mechanically mixed.

These are described under their different heads—the origin of the name is unknown. The term acidic used above, implies a large percentage of silica, the acid, in contradistinction to "basic," the reverse. Acidic rocks contain above 60 per cent of silica, and range as high as 80 per cent. The word granite applies not only to the well known rock, but to a group of rocks called granitic—as Porphyritic granite, Granulite, Syenitic granite, Graphic granite, Gneissic granite, and a number of other varieties. The constituents, too, vary as to state of aggregation; sometimes one mineral is largely in excess, and in other instances another. The granulation also differs, sometimes so fine-grained that the rock looks almost homogeneous, at others the minerals are in large distinct crystals or masses. Other minerals are also sometimes found in granite, as tourmaline, zircon, chlorite, hornblende, steatite, and others, which impart a somewhat distinctive character to the rock. These admixtures and conditions of texture render it extremely difficult to distinguish one rock from another. Until the microscope was called to the aid of the lithologist, the difficulties seemed insurmountable, as the skill of the chemist failed to distinguish rocks of a similar character; but now a thin section placed in the focus of a suitable microscope reveals distinctive features more decisive to the eye of the practical observer, than the results of a complex chemical analysis. The analysis is not, however, to be despised, for both are necessary in many cases. When hornblende replaces mica, granite becomes Syenite, and when the constituents are laminated or foliated the rock is called Gneiss, pronounced "nice." Graphic granite or Pegmatite contains but little if any mica, and is sought as a constituent in the manufacture of porcelain.

The following is an analysis of a typical specimen of granite, selected from many published:

Silica	73.00
Alumina	13.64
Oxides of iron and manganese	2.44
Lime	1.84
Magnesia	0.11
Potash	4.21
Soda	3.53
Water and loss	1.20
	99.97

The specific gravity of ordinary granite is 2.66. A cubic foot weighs 166.2 pounds. Granite, like many other rocks, absorbs water, some more than others. This is an important matter in considering the value of a building stone. The power to resist crushing also differs with granites from different quarries. The experiment to determine this is made on samples cut to certain uniform sized cubes, from one to six inches, as circumstances require. The harder the stone the smaller is the cube acted upon. Whatever machine or appliance is used, it must be provided with a gauge, to indicate the force applied. Granite has always been a favorite building stone, under the impression that it was as nearly as possible indestructible. This has been proved a fallacy, as mentioned elsewhere. In the mild and dry climate of Egypt granite has resisted the elements well, but, even there, it has suffered material decay, as seen on some of the granite walls of temples. No doubt that rock would endure as long in the dry deserts of southern California and Arizona.

Granite is quite common and abundant in California. The great bulk of the Sierra Nevada is composed of this rock. It is also quite abundant in the Coast Range. Near San Francisco it occurs at Tomales Point, Marin County, Bodega Head and Punta de los Reyes, at Point Carmelo and at Cypress Point, near Monterey, where it has been quarried. At Folsom, in Sacramento County, also extensively quarried. In Amador County, near Volcano; near Grass Valley, Nevada County; in the Temescal range, San Emidio Cañon; Tehachipi, and Tejon.

The first stone building erected in San Francisco was commenced late in 1851, and finished early in 1852. It still stands near the corner of California and Front Streets—204–210 California Street—and is in as good condition now as when first built. The granite was imported from China; the blocks were cut in that country, and laid up by Chinese workmen. There is no evidence of the action of time on the stones, and it may be fairly inferred that granite in San Francisco is a good building stone. The building was erected by Ebbets & Co.

An iron front has been made to replace part of the granite in the lower story. The building was quite an object of interest and pride to the pioneers of California, and was widely known as *the granite building.*

Parrott's building, on the corner of California and Montgomery Streets, long occupied by Wells, Fargo & Co., and now the Union Club, was built later in 1852, of the same Chinese granite, and is also in perfect condition as far as the corroding influence of the elements is concerned. Still later, LeCount & Strong built the granite edifice on Montgomery Street, No. 517, which was occupied by them.

The marble building, No. 614 Washington Street, was erected in 1854, of marble imported from Vermont. It is a handsome building, but the stones are much weathered. Some of them are still perfect, from which circumstance it would seem that the material is not uniform, and was not well selected. The building was erected by Mr. Truebody, and is still owned by him.

The first California quarry opened was at Folsom, Sacramento County. Mr. G. Griffith, as early as 1853, furnished granite for Wells, Fargo & Co.'s building at Sacramento, and for the Government works at Fort Point and Alcatraz. The Penryn quarries, Placer County, were located by Mr. Griffith in 1864. Penryn is about twenty-eight miles from Sacramento, on the Central Pacific Railroad, and eight miles from Auburn, the county seat of Placer County. The following description is taken from the San Francisco News Letter:

The Penryn quarry is practically inexhaustible. The present demand, which is to the extent of ten thousand tons a year, is steadily increasing, and the orders are from all points of the coast. For external walls and inclosures, this granite is often used in the simple hewn form; but there is a growing requirement for the polished material, more particularly for sepulchral urns, obelisks, and monuments, and for the grand approaches to the more stately mansions of the wealthy. So wide has been the extension of the taste for this polished granite, that Mr. Griffith has built at his quarry a large polishing mill, the only one of the kind in California. This is a building two hundred feet long by forty feet wide, and its present capacity, which is, however, to be largely increased, is of one hundred cubic feet per day. There are two stone polishing carriages for flat surface work, each twenty-six feet long by six feet is width, and worked by a spring wheel, which is driven by two belts. A stone of more than ten tons weight can be polished on these. The mill has also two polishing pendulums and two very powerful lathes, capable of polishing with ease a solid block of ten tons weight. Besides these there are eight vertical polishers, every kind of mold, both large and small, and of machinery for flat surfaces. The derricks are, of course, very numerous, the six largest being each able to lift twenty tons with ease.

To work the derricks and the polishing mill there are three steam engines; and the force employed by Mr. Griffith is, four blacksmiths, two carpenters, three engineers, and one hundred and fifty quarrymen and stone-cutters. Not unfrequently the numbers are very much greater, and the vast stone sheds, with their room for two hundred stone-cutters, are often found crowded. It is but lately that Mr. Griffith has opened a quarry of very beautiful black granite, and this material will be largely used in the adornment of Mr. J. C. Flood's new residence at Menlo Park, the contract for all the stonework having been made with Mr. Griffith. The buttresses which are to support the walls of this great building, according to the designs of Messrs. Laver & Curlett, the architects, are to be of carved and polished black granite; and the same beautiful material will be employed for the coping of a beautiful fountain in the grounds.

Among the more notable buildings and great public works for which the Penryn quarry has furnished the granite, are the United States Mint, the New City Hall, the New Stock Exchange, the contract for which amounted to $70,000, the Real Estate Associates building, which took to the amount of $25,000, and many of the well-known residences of city magnates, such as those of Governor Stanford, Charles Crocker, Mark Hopkins, and others. The contract for the Dry Dock at Vallejo, originally made with another party, was subsequently given to Mr. Griffith. This amounted to $130,000.

When I visited Penryn in 1880 I noticed a large pile of pavement blocks, two hundred thousand, more or less, which Mr. Griffith informed me would not pay to move, owing to cost of transportation by rail. I was specially interested in the machinery for polishing. The beautiful vase, No. (3364), in the State Museum, was cut and polished at Penryn, and presented to the State by Mr. Griffith. The work is first cut nearly into the required shape, after which it is placed in the lathe; iron molds of the form intended are held against it and fed with sand or emery and water until the form is perfect, when a polish is given by emery and oil, followed by a final application of putty powder on felt. Plane surfaces are cut and polished on a moving bed, over which pass revolving discs of iron or steel.

At Rocklin, also in Placer County, there are extensive granite quarries. The stone here is of a finer texture and lighter color than that at Penryn. Mr. Griffith owns a quarry at this locality also. At the time of my visit large blocks were being shipped to the dry dock at Mare Island. Steam engines were generally used for hoisting the blocks from the quarries, but in one case this work was done by two yoke of oxen. In one direction, parallel to natural north and south fracture, technically called "rift," the rock splits with ease. In all other directions it frequently breaks roughly, or splits with difficulty, if at all. Along the faces of natural fracture may be seen flattened crystals of white iron pyrites, in some cases oxidized to hematite or limonite.

The following tests of California granites were made at the Risdon Iron Works, of San Francisco, and are furnished by Mr. Griffith:

Three and one half by three-inch cubes	70,000 lbs crushing force.
Three and one half by three inch cubes	90,000 lbs crushing force.
Three and one half by three-inch cubes	50,000 lbs crushing force.
Penryn, three-inch cubes	72,000 lbs crushing force.

Gneiss, as before mentioned, is a stratified or foliated granite. Experiments at New York and elsewhere have shown that it is a useful and durable building stone. It is found at several localities in California; (5086) is a specimen said to be found in place on the peninsula of San Francisco, but this is very doubtful. Large quantities are sent to San Francisco by schooner from a locality I have not yet learned. The quality is good.

Mica schist is a foliated rock, consisting of mica and quartz; when the latter is largely in excess, it is called quartz schist. It is a useful building material in some cases. No. (4236) is from the Berkeley hills, and (4239), with garnets, is from the mouth of Russian River, Sonoma County.

Porphyry is a name applied to those rocks of plutonic origin, consisting of a compact base, in which crystals of feldspar are imbedded. The crystals are generally white, or light-colored, while the base is of distinct colors—green, red, gray, purple, etc. The chemical or mineralogical composition of the rock is not indicated by the name. The feldspar crystals are generally dull, and do not have the fresh sparkling appearance of the same mineral in the crystalline rocks. Porphyries are found in many beautiful varieties in California, notably in the Inyo Mountains and ranges lying east of the Sierra Nevada, and are always associated with mines of silver or lead. They are the best of building stones, and are highly ornamental and beautiful. No. (4057) is from Placer County, and is said to be found in large quantities. It is very beautiful and equal to the finest porphyries of Egypt or Europe; (4384) is an Indian mortar of porphyry found near the Forks of Salmon River, Siskiyou County. Very beautiful varieties (5161) are found in rolled pebbles at Monterey and on the beach at Pescadero.

Sandstones or freestones are sedimentary rocks quite common in California. Some varieties make the best and most durable building stones, as for instance, the Ohio sandstone used in New York City. This rock is useful also for making grindstones, and as a fire resisting material. The Pancake Mountain sandstone, of Nevada, is one of the best materials known for the construction of furnaces. It is a singular fact that sandstones have been brought to San Francisco from New Zealand, and used in the erection of buildings, when we have quite as good, and, perhaps, better in this State. (4153) is a sandstone which crops on the beach at Pescadero, San Mateo County. The same formation may be found at several other localities in that and other counties. In it petroleum is found on Tunitas Creek. The same occurs near Alma, Santa Clara County, at which locality oil wells have been sunk. (4215) is an excellent sandstone suitable for building from Eureka, Humboldt County. (4258) is a red-colored sandstone from Santa Margarita Ranch, San Diego County. 4480 is from Glenn Mills, San Mateo County. (5081) is from Sonoma County near the Great Eastern Quicksilver mine. A yellow sandstone crops on the summit of Telegraph Hill, San Francisco, which might be utilized. (1518) is an interesting specimen, consisting of the constituents of granite, with hornblende, but sedimentary, found on Telegraph Hill, San Francisco. On the road from the lime kiln to Clipper Gap, Placer County, may be seen the ruin of an old kiln near which a remarkable formation crops out on the sides of a small ravine behind the ruined kiln. It is a light colored stratified rock, dipping slightly from the horizontal, and in portions somewhat distorted. The edges of the strata are very uniform and parallel, generally about two inches in thickness where the formation is cut by the small stream. The walls have the appearance of the floor of a bowling alley. The large slabs are easily quarried, and have been somewhat utilized in building the old kiln, and in a wall at Clipper Gap. The formation is at least thirty feet in thickness, lying unconformably on a dark colored slaty rock. This rock seems to be suitable for flagging and other building purposes. The following tests were lately made on sandstones from Almaden, Santa Clara County, at the Risdon Iron Works:

Dark colored six-inch cubes	140,000 lbs crushing force used.
Light colored six-inch cubes	54,000 lbs crushing force used.

(4742), a fine brown freestone, resembling that used in New York, is from Coronado Island, twenty-five miles south of San Diego, Lower California, Mexico. Diorite, called also Greenstone, or trap rock, is a basic, plutonic rock, an intimate mixture of hornblende and feldspar, generally albite, but never orthoclase. The rock is fine textured, and usually green colored. Specific gravity about 2.7, containing from 47 to 58 per cent of silica. Diorite is very tough and hard; properties rendering it suitable for pavements and road making. It is probably better for street blocks than the basalt, now so extensively used for that purpose. There is a beautiful variety called "orbicular diorite," or "Napoleonite," because first found in Corsica, the birthplace of Napoleon, which includes globular masses of dark-colored diorite in a lighter-colored rock, but also diorite. No. (1857) is a fine specimen of this rock, from the Corsican locality, and No. (1859) is from Section 17, Township 11 north, Range 8 east, Mount Diablo meridian, eight miles from the town of Rocklin, Placer County. This beautiful stone will be highly appreciated at some future time. (3016) is a diorite of good quality, with section for microscopic study. Diorite is quite common in California, being often found as wall rock for gold and silver mines.

Lava, Basalt, Trachyte, Pumice, Obsidian, etc., are names given to igneous rocks, ejected from volcanoes. The name lava is general, and applies to all the others; many varieties have a distinct and known composition, and are recognized as rocks. Basalt is basic, while others are acidic. Volcanic rocks are very common in California. Basalt is used as a street pavement. There are many specimens in the State Museum. At Mill Creek, three miles southwest from Healdsburg, Sonoma County, there are fine basaltic columns. The same may be seen in Butte County, near Morris Ravine. Pumice stone equal to that brought from the Lipari Islands, and a deposit of the same rock, found on the south side of Lake Merced, near San Francisco, has supplied the market for a number of years.

Pozzuolana is a volcanic ash, or sand, which is extensively used as a cement, having certain properties which render it extremely useful for building purposes. When ground and mixed with water, and from one third to two parts of lime, it sets into a hard cement or mortar, and equally well under water. Mr. J. S. Hittell sent samples from Rome to the State Museum, with directions for use. A copy of the Daily Opinion of Rome, March 4, 1883, was sent with it, containing the following paper, translated by Dr. Paolo De Vecchi, of San Francisco:

New Method of Finding the Value of Pozzuolana.—One of the researches the most slow, and for industrial chemistry not always reliable, is that of determining the good quality of pozzuolana, so as to give, in conjunction with lime, a mortar of great resistance. Now, Mr. Landrin proposes a method of analysis of his own, which, in preference to those already known of Vicat and Canndenberg, has the advantage of only requiring a very short time for the experiment. In fact, Vicat's method, which consists in observing the action of the water of lime on the pozzuolana, requires, in order to obtain satisfactory results, a period of several months. The author remarks that the most careful analysis of the pozzuolana cannot determine its qualities, but only its components. But, if the pozzuolana is treated with hot chlorohydric acid, there will be obtained a soluble and an insoluble substance, and it will be seen that the latter is nearly entirely composed of silicious matter. Mr. Landrin adds that it is precisely the more or the less quantity of silica capable of being united with the lime that determines the quality of the pozzuolana. But for such determination it is not the quantity of silica shown by the analysis that must be computed, but only that which can combine with the lime. Mr. Landrin experimented on three qualities of pozzuolana, one coming from Reunion Island, one from Italy, and the last manufactured near Paris. Relying on the fact that the hydraulic silica has the property of reducing the water of lime, he treated the pozzuolana with boiling chlorohydric acid, and put a certain quantity of the insoluble substance thus obtained in water of lime. In only twenty-four hours he was thus able to ascertain that the action of this silica was such that it reduced, in the true pozzuolana, an enormous quantity of water of lime. The silica of the Italian pozzuolana reduced in that short interval about one hundred and five times its volume of water of lime. On the contrary, the French artificial pozzuolana, which to the analysis had given a quantity of silica larger than the two others, only reduced in the same interval four times its volume of water of lime. In effect this latter pozzuolana produces but an inferior quality of cement. The experiments made in comparison with the preceding methods, that is, treating not the insoluble substance of the pozzuolana, but the pozzuolana itself with water of lime, have shown that these methods can in nowise be compared with the rapidity of the one just described.

About the same time a light colored brecciated rock was brought to the State Mining Bureau, found in the hills near Berkeley, and claimed to be pozzuolana. Mr. Samuel Kellett, practical plasterer, made experiments, and announced it to be a hard setting cement, like pozzuolana. On the strength of this opinion a laudatory notice appeared in the city papers. Subsequently Mr. Kellett reversed his opinion, having made other experiments with less satisfactory results. My own experiments failed to produce a hard cement. Others claimed to have found a method of doing so, but kept the details a secret. An analysis was said to be made of this material, many years ago, by Mr. G. E. Moore, a well known chemist. This analysis is given below, No. 1, and for comparison one of the true Roman pozzuolana, by Berthier, No. 2:

	No. 1.	No. 2.
Silica	44.4	44.5
Alumina	15.6	15.0
Lime	8.6	8.8
Magnesia	4.1	4.7
Oxide of iron	11.6	12.0
Potash	1.5	1.4
Soda	3.9	4.1
Water	9.5	9.2
	99.2	99.7

It will be noticed that there is a striking similarity. It may be that subsequent experiments may show that the rock is really pozzuolana, in which case it would be a very valuable material to be used in building. If this should fail to give satisfactory results, some of the other volcanic materials may prove to be this most desirable cement.

Serpentine is a hydrous silicate of magnesia, described elsewhere. It is abundant in California, being generally associated with chromic iron, and magnetite, hematite, limonite, etc. It is more an ornamental than a building stone; slabs for interior work are both beautiful and durable. It is much employed in Europe in combination with marble. It is a metamorphic rock, and not, as formerly supposed, of eruptive origin. Verde antique is a beautiful green serpentine, mixed with carbonate of lime, and colored by oxide of chromium. There are reasons to hope that this rock may yet be found in California.

Limestones, including *Marble*, *Travertine*, and *Tufa*. These rocks make excellent building stones; they will be fully described under the head of Calcite.

Dolomite is a magnesian limestone, abundant in California, and well adapted for building purposes, fully described under the head of Dolomite.

Slate is a useful and very durable building material, generally used as a covering for roofs, and sometimes for the sides of buildings, to render them fireproof. The slates are silicious sedimentary rocks; one cubic foot weighs from 170 to 180 pounds.

The following is from the second annual report, 1882, folio 96:

Both slate and shale are, no doubt, sedimentary mud or silt, which, from great age, have become indurated and in most part were formed at the bottom of the sea. The fossils contained in them are conclusive evidence of this. Natural forces have bent and warped the strata until they have become plicated like the leaves of a book, or a pile of writing paper pressed laterally. In slate quarries lines of stratification of various colors may be seen marking the different periods of deposit; the lines of cleavage lie generally in a certain direction, which is called the strike; the inclination is called the dip; they were all laid in horizontal strata. Slate is altered shale; instead of cleaving in the plane of stratification, as shale invariably does, it now divides at an angle with the natural deposition. The new lines of cleavage are called cleavage planes. The line of strike in the slates is almost invariably parallel to the trend of the mountains, and the upheaval in the surrounding country, from which may be inferred that some lateral pressure has bent the strata and caused at the same time the slaty cleavage.

To prove this, Mr. Sorby, of London, made some interesting and conclusive experiments bearing on this subject. He subjected a portion of clay without cleavage or stratification to very great pressure. The original mass contained scales of oxide of iron, which were distributed throughout the clay without regularity. The clay was reduced by the pressure to half its volume. The result of these experiments was the development of certain singular phenomena. The scales of iron oxide had arranged themselves in parallel lines, and a slaty cleavage was now apparent, and singularly, the cleavage planes were at right angles with the pressure applied. Professor Tyndall has shown that pure white wax can be made to cleave into parallel scales if sufficient pressure is applied. Were these experiments not sufficient to prove that slate, unlike shale, has been under great pressure, other facts may be stated.

In the silurian slates of Europe the imbedded fossils are frequently distorted, and the elongation is always in the direction of the cleavage planes, showing that the movement of particles which caused the lamination was in the line of least resistance, or at right angles with the pressure. When there are no fossils present, small gravel and pebbles are found to be arranged like the iron scales in Mr. Sorby's experiment, with the longest axis in the direction of the dip. When neither fossils nor large particles are present, a thin slice placed under the microscope will show the finest particles and accidental scales of mica arranged in the same manner. It may be assumed that any fine grained sedimentary rock submitted to sufficient pressure by the forces of nature, will develop the same slaty structure.

Good slates are found in California. Any future demand for this indispensable building material will be filled from localities already known. No. (315) is from a cropping between Cave City and San Andreas, Calaveras County. In Oregon Gulch, near the Sunrise Copper Reduction Works, section four, township four north, and range ten east, there is an outcrop of very good building or roofing slate, which is convenient to the new San Joaquin and Sierra Nevada Narrow Gauge Railroad, which will supply this material when required. No. (4079) is from Placer County, near Emigrant Gap; (4959) is from Butte County, near Red Hill. In San Bernardino County, at Slate Range, slates suitable for building purposes, perfectly straight and of large size, are found in unlimited quantities.

Artificial Stones are made in California, and, as far as experience goes, they last very well and give satisfaction. For sidewalks, cement is extensively used.

Ransome's Concrete is largely employed for foundations.

Stone-cutting.—Sundry machines have been invented to supersede the toilsome work of hand-cutting, but there is a wide field for invention in this direction, and pecuniary reward to the inventor who will produce a perfect machine for dressing hard stones.

A machine was exhibited in the British section of the Paris Exposition of 1878, by Brunton & Trier, Wellington Road, Battersea, London, S. W., who claimed to do all work with their machine that could be required. Rotating diamond-cutters have been used in the dressing of marble, and the sand-blast employed in sculpturing very soft stones. In 1876, in Philadelphia, chilled iron in globules was used in sawing granite instead of sand with considerable success. In Boston in 1879 a machine was set up by which it was claimed that granite could be planed like wood. As these machines are not used practically to any great extent, it is fair to infer that they do not meet the requirements of stone-cutting, and the coming inventor has still an open field.

Buhr Stone—see Quartz.

25. CALAVERITE. Etym. "*Calaveras County,*" where first found; see also Tellurium.

A rare mineral described by F. A. Genth, in 1868. First found in the Stanislaus mine. It is a telluride of gold and silver, having about the following composition:

Tellurium	56.00
Gold	40.92
Silver	3.08
	100.00

In a paper "on some Tellurium and Vanadium minerals," read before the American Philosophical Society, August 17, 1877, Professor Genth published an analysis made of a specimen from Colorado, in which he obtained nearly the same results, and found the hardness to be 2.5; sp. gr. 9.043; color, bronze yellow; brittle. B. B. on ch. yields a globule of gold, coloring the flame green. It is soluble in nitro-muriatic acid, except the silver, which is changed into an insoluble chloride.

This mineral occurs sparingly in the mines of Carson Hill near Angel's, at the Morgan mine with massive gold, at the Melones mine, Calaveras County, and at the Golden Rule mine, Calaveras County.

26. CALCITE. Etym. "*Calx*"—lime (Latin). Carbonate of Lime, Calcareous Spar, Calc Spar, Dogtooth Spar, Iceland Spar, Limestone, Lithographic Stone, Marble, Stalactite, Stalagmite, Travertine, Tufa, Thinolite, Anthraconite, etc.

This is a very abundant mineral in nature, being found in many varieties. It is carbonate of lime having, when pure, the following composition (CaO, CO_2):

Carbonic acid	44.0
Lime	56.0
	100.0

Atomic weight (50); sp. gr. 2.5—2.8; H. 2.5—3.5; infusible, but when heated becomes caustic, and colors moistened turmeric paper brown. In point of blowpipe flame, it glows with brilliant white light (lime light), dissolves in acids, with effervescence. The solution made alkaline with ammonia, throws down a white precipitate with oxalate of ammonia, and also with carbonate of soda. Lime is an oxide of the alkali metal *Calcium*, one of the most widely diffused elements, being found in the animal, vegetable, and mineral kingdoms, always combined with other elements, singly or in groups. In the mineral kingdom it is found as carbonate, sulphate, silicate, tungstate, or fluoride, and as a constituent of many complex minerals. Lime has been known and utilized from the earliest ages. Calcium was discovered in 1808 by Sir H. Davy. It is a light yellow metal, the color of silver gold alloy, having about the hardness of gold, and when freshly cut considerable luster. Unless protected from oxygen, it soon oxidizes and loses its metallic character. It is very light, the sp. gr. being only 1.5778. It is very ductile, and may be hammered into sheets as thin as paper. It is obtained by the following methods: Chloride of calcium, in the presence of mercury, is subjected to the action of a strong current of galvanic electricity, when the metal calcium is reduced and combines with the mercury in the form of amalgam. This is heated to redness in an atmosphere of hydrogen, or vapor of rock oil. The mercury is sublimed, leaving the calcium in a metallic state. Or the following: Two equivalents of chloride of calcium and one of chloride of strontium, with a little chloride of ammonium, are fused in a small porcelain crucible while subjected to a strong current of galvanic electricity. The calcium forms in small beads, which are removed from time to time.

The metal dissolves in water, forming lime water, decomposing a portion of the water in doing so, and setting hydrogen free. The atomic weight of calcium is 20, and the symbol Ca. By the new system the atomic weight is 40, or double the old. Lime, also called *caustic* lime is the oxide of calcium, as before mentioned, written Ca O, or one equivalent of calcium and one of oxygen.

Calcium, Ca.	20
Oxygen, O.	8
	28

It is commonly prepared by strong and long continued ignition of natural carbonate of lime (limestone); it is less frequently obtained from oyster shells, coral, chalk, and in California and Nevada from thinolite, a tufaceous mineral found in the beds of ancient alkaline lakes. Pure limestone cannot be over-burned, even when subjected to the strongest heat; but when containing clay or other impurities, it may be *dead-burned*, and rendered useless by too great a heat. When caustic or quicklime is mixed with water an intense reaction results. Heat is evolved, and a chemical combination of the water with the lime takes place; the lime is then a hydrate, or slaked lime, thus (CaO, HO):

CaO	28
HO	9
	37

Lime is almost indispensable in building and the arts, and California is fortunate in having an abundance of limestone within her borders, not only as a source of lime, but in the form of beautiful marbles mentioned elsewhere. Most limestones have been formed on the bottom of the sea, from shells and corals, which are often found imbedded in it as perfect in form as when alive. Some of these limestones have so changed (metamorphosed) that they have become crystalline, and sometimes veined by foreign substances they contain, while at others they are as pure and white as snow. They are then called crystalline limestone or marble.

LIME—MANUFACTURE AND PRODUCT IN CALIFORNIA.

If limestone occurs sparingly in Oregon and perhaps also in Washington Territory, as stated by Williams in his work on the Mineral Resources of the United States, there is still known to be enough of it in these countries for all practical purposes. In all the Pacific States and Territories there is sufficient lime manufactured to meet local requirements. For a time after the American occupation of the country, including the early mining era, not much lime, cement, or plaster was used in California; the buildings put up during that period having been mostly constructed of wood, the walls and ceilings being covered with cloth and paper instead of plaster. But few houses with brick chimneys, and still fewer with brick or stone foundations, were then to be seen. The destructive conflagrations that occurred so frequently in those early times calling for a more substantial style of buildings, lime in considerable quantity became a necessity. To supply such want the manufacture of this article was begun as early as the Spring of 1851, when a Mr. Shreeve commenced burning lime at the Mount Diablo quarries, near Pacheco, Contra Costa County, he having been the pioneer in the business under the new regime, for this was one of the few industries practiced by the Spanish settlers in California before the country changed hands. Though carried on in a small and primitive way, these people made a tolerably good article of lime, as is attested by the durability of some of their buildings and the manner in which the whitewash they applied to them has withstood exposure to the weather.

In the month of June, 1851, Mr. Davis, of the firm of Davis & Cowell, San Francisco, started a kiln in the hills back of Mayfield, Santa Clara County. Mr. Davis, who came so near being the pioneer in this business, has continued it ever since, having for many years past been the largest manufacturer of this commodity on the Pacific Coast. Gradually, as towns and cities sprang up, and new industries were multiplied, the business of lime burning from these small beginnings extended to other parts of the State, until nearly every populous neighborhood containing the stone came to have its kiln, whereat enough lime was made for home purposes. During the three or four years that followed the gold discovery, the little lime required here was imported from the Eastern States. Owing to danger from spontaneous combustion on the voyage, this lime was slaked before being shipped, and arrived here in a condition much resembling putty.

THE PRINCIPAL LIMESTONE BELT OF THE STATE.

While limestone occurs in many parts of California, the principal deposit consists of a belt of this rock extending along the westerly foothills of the Sierra Nevada, traversing in a northerly and southerly direction the main gold field of the State. This belt, which reaches from Mariposa County to Butte, a distance of 150 miles, varies in width from two or three hundred yards to several miles. In the vicinity of Columbia this rock consists of a good quality of marble, susceptible of taking a high polish. A metamorphic limestone is found at intervals for hundreds of miles along the Coast Range of mountains. From this source the towns and counties on the seaboard obtain most of their supplies, the foothill belt supplying the central mining regions and the great agricultural valleys adjacent on the west. On this belt, in El Dorado County, are located the "Alabaster Lime Works," consisting of a "Monitor" kiln having a capacity to burn 3,000 barrels per month. The property owned by the H. T. Holmes Company embraces what is known as the "Alabaster Cave," one of the natural curiosities of California. The lime made at this locality is noted for its purity and whiteness, and being well suited for the purification of gas, is used by several gas companies in the interior for that purpose. The kilns near Clipper Gap, Placer County, also owned by the Holmes Company, and at which a good deal of lime was formerly turned out, having been closed down for the past two years, no lime has in the interim been made there.

DEPOSITS AND WORKS IN SANTA CRUZ COUNTY.

The principal lime district in the Coast Range and the most productive locality in the State is situate near the towns of Felton and Santa Cruz, in Santa Cruz County, where there occur extensive beds of crystallized limestone of superior quality. At this point several companies have put up works, each having large capacity. The plant of the H. T. Holmes Company, who are operating near the town of Felton, consists of five large kilns, two of them being of the improved Monitor pattern. In 1883 this company made here about fifty thousand barrels of lime, hardly more than half what they were capable of doing. The product of their kiln, in El Dorado County, amounted, for the year, to about fifteen thousand barrels, operations there having been suspended during the Winter. Blochman & Cerf, whose works are also near Felton, turned out during the year about the same quantity as the Holmes Company, though they, too, have capacity to make more than twice as much as they have done for several years past. The works of Davis & Cowell, near the town of Santa Cruz, comprise six kilns of the old fashioned style. This firm also makes a good deal of lime at Cave Valley, five miles south of Auburn, Placer County. This lime, answering well for glass-making, is used by the San Francisco and Pacific Glass Company, at their works in this city. About three fourths of all the lime that comes to the San Francisco market, and one third of all that is produced in the State, is made in the vicinity of Felton and Santa Cruz, where the facilities for manufacturing and shipping this article are extremely good. The stone here, besides being plentiful and of the best kind, can be easily quarried. Wood and water are abundant, and shipments can be made either by rail (the South Pacific Coast Railroad running within a mile of the quarries), or by vessels through the port of Santa Cruz, twelve miles distant from Felton. From the redwood trees that abound in the neighborhood a good barrel can be cheaply made for putting up the lime. This Santa Cruz lime, of which two kinds are made, common and finishing, is held in good repute, both for its strength and finishing qualities. These several companies employ from thirty-five to forty men each, this number including quarrymen, wood choppers, teamsters, etc.; wages, $1 50 per day, though much of the work is done on contract.

In the Hydro-Carbon Lime Works at Colton, San Bernardino County, petroleum is being used as fuel, and, as it appears, with success. Whether the experience had here would be of universal application is questionable. Where other fuel would be rather dear and petroleum rather cheap, as at Colton, there might be economy in burning the latter, while there would be none were these conditions reversed. Further experimenting may be required to establish the value of petroleum as a fuel for burning lime, even at Colton.

PRICE AND PRODUCTION IN THE PAST.

For a time, at first, lime sold in San Francisco for as much as eight or ten dollars per barrel. But these extreme rates did not hold for more than a few years—home competition having gradually reduced prices to the very moderate rates that for a long time have ruled everywhere on this coast. As many as twenty years ago lime sold in this city at $2 25 to $2 50 per barrel; about one dollar more than present rates. The receipts of lime at San Francisco during this period were, approximately, as follows; the entire quantity being the product of this State:

Year.	Barrels.	Year.	Barrels.
1863 (estimated)	74,000	1874	143,513
1864	73,553	1875	182,631
1865	90,037	1876	174,758
1866	89,786	1877	155,113
1867	102,708	1878	144,072
1868	125,157	1879	104,405
1869	119,266	1880	133,097
1870	105,342	1881	123,779
1871	111,574	1882	133,306
1872 (estimated)	112,062	1883	158,035
1873	143,513		

The prospects of the lime-making interest for the incoming year are considered tolerably good. The quantity of lime made in the United States in 1882 is given at 31,000,000 barrels (of 200 pounds each), having a total value at the kilns of $21,700,000.

The "Monitor" lime-kiln consists of a cylinder of boiler iron, lined with fire-brick. It is usually located on a hillside, so that the limestone can be run from the quarry by means of an elevated tramway to a door in the upper part of the kiln, ten to twenty feet above the fire. Above the cylinder an iron smokestack rises twenty to thirty feet to insure a draft; below the cylinder are the fire-places, consisting of a number of fire doors opening into converging openings, in which wood is burned over ashpits, into which the ashes fall through gratebars. The limestone is fed into the upper door and drawn out, when properly burned, through a lower opening below the fires, at which point it is shoveled into barrels. The advantage of the Monitor lime-kiln over the old-fashioned style consists in the fact that the former can be run continuously, whereas with the old kind, when a batch of stone has been burnt, the fires must be extinguished, and renewed after the kiln is again filled with stone. This, besides the trouble of putting out and relighting the fires, causes considerable loss of time. The cost of the Monitor kilns varies from three to five thousand dollars, according to capacity.

Limestones, including the variety known as marble, are found in considerable abundance in several parts of the State, as before mentioned. The following counties are represented in the State Museum:

Amador County (4894).—White marble, nine miles north of Ione; good building stone.

Butte County.—Blue limestone, or marble (4376), near Pence's ranch, extends several miles. Found by Prof. Whitney to be carboniferous; the fossils found were *Spirifer lineatus* and *Productus semireticulatus.* This limestone would no doubt make a good building stone. It is soluble in hydro-chloric acid with effervescence, leaving a small hepatic residue. When struck with a hammer it emits a fetid odor (anthraconite), burns to a pure white lime which slacks perfectly; at the time of my visit I looked very carefully but found no fossils.

Calaveras County.—Pearl gray marble (3387), with dark markings; highly polished; from a large deposit. A beautiful marble and valuable building stone.

El Dorado County.—At the Alabaster Lime Works, so called from the whiteness and purity of the limestone, situated near Newcastle, Placer County, which is the shipping point on the Central Pacific Railroad, the limestone, or marble, varies from a pure white to an agreeable gray color, and takes a high polish. The lime is of excellent quality, and the stone would doubtless make a valuable and durable building material. The lime is generally shipped in bulk, and by the carload of ten tons, and sold in Virginia City, Marysville, Red Bluff, Chico, Sacramento, and San Francisco. The Folsom Prison is entirely built with this lime. Mr. Ewing, the Superintendent, found some fossils, or what he thinks were fossils. From his description they may have been encenites, but from the metamorphic character of the rock I am inclined to doubt it. The quarry, which is across the stream from the Alabaster Cave (to be hereafter described), was opened in 1877. The face of the quarry is eighty feet high. The floor is thirty feet above the lower floor of the Monitor kiln, which has a capacity of three thousand barrels per month. The old stone pit-kiln, first used, was on the side of and near the entrance of the cave. Another, and larger one, was built in 1862. Five tons of lime are hauled at a load, one trip per day, in four wagons, drawn by two teams of horses.

Humboldt County.—A beautiful mottled gray marble has just been brought to the State Museum from near Eureka. It is soluble in acids, leaving but a small residue, contains but little magnesia, takes a high polish, has a uniform texture, and seems to be an excellent marble.

Inyo County.—In the Inyo range, on the east side of Owen's Valley, there are large outcrops of limestones and marble, from nearly black to pure white. These mountains promise a plentiful field for future research, and a thorough study of them will probably throw much light on the geology of the State. Marble is also found in the foothills of the Sierra Nevada. At "Big Pine" there is a cropping of beautiful white marble, of which there is a cube, cut and polished, in the Museum. No. (3669) is a peculiar formation. The following is the Museum label:

Rock Specimen—Locality, Inyo Range, 2,000 feet above Owen's Valley, Inyo County, Cal. Of peculiar interest, consisting of alternate layers of quartzite and limestone. On the weathered surface the limestone has been cut away, probably by the action of drifting sand, while the quartzite remains clear and sharp. This specimen is an interesting study, the question suggesting itself how the two minerals were deposited so evenly and with such alternate regularity. When found, the strata were vertical.

No. (4654) is limestone containing fossil corals, weathered by drifting sands, found in Death Valley.

Kern County.—No. 5019 is a water-worn bowlder of limestone of good quality, found on Posa Creek. The deposit is not known.

No. (710) is a beautiful brecciated yellow marble, from Tehachipi, which will some day be much prized. Onyx marble (aragonite, 2327) is found at a mineral spring six miles above Kernville.

Lithographic stone (2789) is found in this county. The exact locality is southeast quarter of Section 12, Township 32 south, Range 34 east, Mount Diablo meridian. The mineral, which is a compact yellow limestone, is said to exist in large quantity, cropping out for half a mile.

While a variety of lithographic stone has been observed at several places in California, none has yet been found of a quality suitable for the uses of the artist. The defects of the California stone do not, however, consist, as is the case with most of that found elsewhere in the United States, in its being brittle, coarse grained, or lacking in uniformity of texture, but in want of hardness. In other respects some of the samples experimented with have given tolerable satisfaction, leading to the hope that when our quarries come to be opened to greater depths the quality of the stone will so improve that it can be used for some and perhaps all purposes. Some specimens of lithographic stone found at the Kern County locality, brought to this city not long since, were pronounced by experts of a better quality than any before obtained in the State. As a stone of this kind, that will answer for fine, or even ordinary work, commands good prices, our prospectors and miners should be on the lookout for such material, while pursuing their vocations. The value of the lithographic stone imported into this State amounts every year to a considerable sum, the total imports into the United States amounting annually to about $120,000.

While this material is found in several States of the Union, notably in Iowa, Alabama, Kentucky, Missouri, and Tennessee, and also in England, France, Italy, Canada, and the West Indies, no first class stone has ever been obtained, except from the quarries of Solenhofen and Pappenheim, in Bavaria. The product of these quarries consists of a fine grained, compact limestone, which is prepared for the artist's use before being sent to market. As the Bavarian stone is costly, with a constant tendency toward higher prices, while its quality is said to be deteriorating, the stone of other countries may, with all its faults, be expected to grow steadily into larger use.

Los Angeles County.—Specimens of limestone or marble from this county were presented to the State Museum by Mr. J. A. Christy. There are two varieties—one light colored, the other dark. They are burned for lime in common pit kilns. Two kilns yield six hundred barrels of two hundred and seventeen pounds at a charge. The old padres burned this limestone, and used it for plastering and whitewashing. Some walls are reputed to be two hundred years old. The quantity is said to be unlimited.

In Monterey County, near Carmelo Bay, a fine white marble is found. Some years ago, the Pacific Carrara Marble Company was incorporated to work this deposit.

Nevada County.—A dark gray, veined marble occurs at Bear Creek, three miles from Colfax. There is another locality ten miles south of Grass Valley, where the same lime has been burned. The limestone is carboniferous.

Placer County.—Limestones and marbles are rather abundant in this county. Several deposits of excellent marble are known near Auburn. (1939) is from a cropping near the iron works, Section 15, Township 13 north, Range 8 east, Mount Diablo meridian. It is white saccharoidal. It has been largely used in San Francisco in the manufacture of mineral waters. It could be cut into large slabs if required.

ANALYSIS.

Silica	0.15
Sesqui-oxide of iron	0.35
Lime	55.72
Carbonic acid	43.78
	100.00

There is a cropping of very compact black limestone (marble), veined with white (2799), within a few feet of the Central Pacific Railroad, near the high trestle a mile or more above Colfax, which has at some time been burned for lime, in a rude experimental kiln, now fallen into decay. The work done at this point has not been sufficient to show the extent of the deposit. A careful examination failed to reveal any trace of fossils. This is not only a beautiful ornamental marble, but is a good and accessible building stone. The Museum specimen has been cut in cubic form and polished. There is a fine cropping of limestone, light gray, with darker gray markings (2807) half a mile below Auburn, on the American River. It is singular that no attempt has been made to utilize the beautiful stone found in this quarry, for building purposes; all the conditions for cheap working are found combined. The river, running a few hundred feet below, would furnish unlimited water power and pure quartz sand. The same power would lower the rough blocks from the quarry to the works at the river, and elevate the finished work to the level of the railroad above the quarry, by tramway and cable. There seems to be no reason why works should not be constructed for the manufacture of marble slabs, mantels, plumbers' goods, etc., to be shipped by rail to a market in a finished state.

ANALYSIS.

Silica	.25
Ferric oxide	.25
Magnesia	Trace.
Lime	55.72
Carbonic acid	43.78
	100.00

There is also a large deposit of similar marble (1863) near Clipper Gap. The following analyses were made of different samples from this locality:

	No. 1.	No. 2.
Silica	Trace.	0.15
Ferric oxide	0.05	0.35
Magnesia	Trace.	Trace.
Lime	55.97	55.72
Carbonic acid	43.98	43.78
	100.00	100.00

(1866) is a white marble from Cave Valley, near Auburn.

Plumas County.—Limestones and marbles are found at Devil's Elbow and Indian Creek in this county, but the Mining Bureau has no special information concerning them.

San Bernardino County.—Limestones are found at several localities in this county, but the most important is near Colton, where lime has been somewhat largely manufactured. The quarries lie in Slover Mountain, half a mile from the town. There are several varieties, the best being a very white fine textured marble. The rock from which the lime is made is gray. There are quarries of limestone also in the San Bernardino Mountains.

San Luis Obispo County.—There are numerous localities of limestone in this county, but little is known of them. The "Onyx" marble has been fully described under the head of Aragonite.

Santa Cruz County.—(2005) and (4147) are marble or limestone of good quality, from the quarry of Davis & Cowell. The lime from this county has been described under the head of Lime. (3372) is a concretion of limestone with diaphragms of harder material, probably silicious. The whole bearing a strange resemblance to a fossil turtle, found seven miles northeast of the town of Santa Cruz. These concretions, known as turtle stones, are not uncommon elsewhere.

Shasta County.— Extensive beds of carboniferous limestone are found in the Gray Mountains, which extend far north along the McCloud River. No doubt these deposits would furnish fine building and ornamental stones. The interesting carboniferous fossils found in these limestones, were first discovered by Dr. Trask, in 1855, and are mostly figured in the first volume of the Paleontology of California, Whitney's Geological Reports.

Tuolumne County.—This county contains extensive beds of limestone and marble. (267) is a beautiful dark mottled marble, from Abbey's Ferry. (904) is a white and beautiful marble, exact locality not given. (3604) is a gray marble from the bed of the Tuolumne River. At Sonora, in the river bed, a beautiful gray marble is found in large bowlders, which have been uncovered in placer mining. There is a deposit of blue limestone near York Tent which makes excellent lime. The Odd Fellows' Hall, Sonora, is laid in mortar made from this lime.

Carbonate of lime is soluble to a slight degree in pure cold water, and more so when carbonic acid is present; water in a limestone country is generally in this condition. In percolating through a calcareous formation, water bears away a notable portion of the rock in solution, which, continued through a geological period of long duration, manifests itself in cavernous openings generally known as *caves.* These caves are found in all limestone countries, and are not wanting in California. There is a charm about these openings in the earth, to the human mind, that is to me quite unaccountable. Most persons delight in exploring a natural cave. They experience a thrill of pleasure, mixed with dread, as they penetrate deeper into the earth and see for the first time gloomy caverns, artificially lighted by the lamps they carry. For this reason caves of any great extent are generally made places of resort, and for the same reason primitive man, and man in more recent times selected such as natural tombs for the dead. In ancient times, in Southern Europe, Asia, and Northern Africa, artificial caves were made under the name of tumuli. A chamber of stone, sometimes exquisitely sculptured and of the finest marbles, was built on the surface of the ground, in which the body of the dead was laid, after which a mound of earth and stones was built over it, sometimes several hundred feet high and covering many acres. Similar tumuli were built in Northern Europe, but of inferior workmanship, and the Eastern States of the American Union are covered with such, many still rising to a considerable height, while others have been leveled by the hand of time.

The caves of California have been in past times used as sepulchres, as attested by the human bones found in them. This was noticed by those who first came to the State after its acquisition by the United States, and it is probable that the Calaveras River was named from the finding of skulls in some cave on its banks. D. C. F. Winslow, writing to the California Farmer as early as 1854, mentions a small cave on the Stanislaus River in which human bones were found. An old Indian informed him that the bones had been placed there during a recent period. In August, 1881, I visited a cave then rediscovered in Calaveras County which contained a large quantity of human bones. I hoped to find some relics that would throw some light on the history of the human race in this country, as similar discoveries have done in Germany, France, and elsewhere, but was disappointed, for nothing was discovered to show that the bones were not those of Indians which had been laid there within a period not exceeding a part of a century. Besides these, nothing was found beyond some charcoal which formed, probably, the torches of those who came to deposit the dead; although two men worked for a number of days, washing the earth of the floor in mining pans, by which any prehistoric implements would have been recovered, had any existed, no discovery of interest was made. This cave, near Cave City, was named "The Cave of the Catacombs." In exploring it, names of visitors were found dating back to 1850, at which time there must have been another opening now unknown. Some of the bones were brought to San Francisco and placed in the State Museum. The sensational articles which appeared in some of the papers at the time, to the effect that this cave had been at one time a prison, in which men, women, and children had been driven to perish by starvation, were wholly without foundation. Cave City, once a celebrated and fruitful placer gold mining locality, was so called from a cave in the limestone, now known as the "Crystal Cave." The town once contained one thousand inhabitants.

"Crystal Cave," according to J. M. Hutchings, was discovered accidentally in October, 1850, by Captain Taylor. It is a very interesting natural curiosity, and at times has been quite celebrated, and has had many visitors, as the books of record show. At the time of my visit it was owned by George Nichols, who was just building a commodious hotel. No effort was made to attract visitors, although it is well worthy of attention, and should be made a place of resort for tourists, who would in the meantime see something of the country on the route to and fro. The "Alabaster Cave," El Dorado County, is nearly equal in beauty to the "Crystal Cave," and is more accessible, being near the great Central Pacific thoroughfare. It is situated six miles southeast from Newcastle, on Section 15, Township 11 north, Range 8 east. It was discovered April 16, 1860, by two workmen, George S. Hatterman and John Harris, who were employed by William Gwynn in quarrying and burning lime. In blasting, they discovered a small opening which led to the cave. The first description was written by Mr. Gwynn, and appeared in the "Sacramento Bee." For a time the cave was visited by many persons, but at the time of my visit, few came to see it; four thousand seven hundred and thirty names were registered and numbered, after which the numbering was discontinued. The really good hotel has fallen into decay. In both the above-mentioned caves, numerous stalactites and stalagmites may be seen, and I observed that on the end of each stalactite there was a drop of water. It is curious to consider that these excavations have been made by the slow, solvent action of water falling drop by drop, and that the same process is going on to-day, but is imperceptible to the senses. Some faint idea may also be gained of the great age of these limestone rocks by considering these facts. The drops do not form rapidly, the tip of the stalactite must be watched for some time before the fall will occur, and considerable time passes before another drop of water takes its place. This slow operation has been going on for centuries. Who can tell when it will cease? The limestone at "Alabaster Cave" is generally faintly blue, and clouded, but some portions are pure white, and appear translucent when a candle is placed behind a thin stalactite. I did not determine the thin comb-like edges of slate which project from the marble ceiling, being less soluble than the limestone. They sometimes resemble the tables on the face of a glacier, but are of course inverted. Bower Cave, in Tuolumne County, on the road from Coulterville to the Yosemite Valley, scarcely deserves the name, being more a grotto than a cave, and more a fissure in the limestone than either. It was frequently visited by tourists in former years, but has now passed from notice. Pluto's Cave, Shasta County, is described by Professor Whitney (Geology of California, volume 1, folio 351) as being very interesting, but it is in lava and not limestone. The manner of its formation is doubtful. On one side of the great limestone croppings near Clipper Gap, there is a small cave extending nearly through the mass, which has been rendered historical as the residence of a band of robbers in early times. It would be interesting to examine the floor for prehistoric remains and bones of animals.

There are specimens of stalactite and stalagmite in the State Museum, from "Bass Cave," Shasta County (1129, 1130), San Luis Obispo County (2817); cave near Volcano, Amador County (3722), and a large number from the Crystal Cave, Calaveras County (133, 3009, 4791).

Iceland Spar is a perfectly transparent calc spar, first found in Iceland. It is used in optical instruments to polarize light. By a singular property a ray of light passing through a crystal, in a certain direction of the rhombus, large or small, into which it naturally breaks, is divided into two, and both are polarized. This phenomenon is called double refraction. If a rhomb of Iceland spar is laid on a sheet of paper, upon which a single dot is made, there will appear *two*. For optical use the rhomb is split into two parts, and recemented with Canada balsam, by which treatment the dispersing power of the crystal is increased, and one ray thrown out of the field. The crystal then becomes a nicol-prism, a full description of which and mode of use will be found in works on optics. Good specimens of this variety of calcite have been found in California. One locality (3709) is Darwin, Inyo County, and another (4452) Santa Clara County.

Dogtooth Spar is a variety of calcite, in which the crystals have a fancied resemblance to the teeth of dogs. Good specimens have been found at Cerro Gordo (Aaron), and on the peninsula of San Francisco.

Tufa, or *Travertine*, is generally deposited by calcareous springs, and sometimes in the bottom of lakes, rivers, or seas holding much lime in solution. The name "Tufa" is derived from the Latin, *tofus*, and "Travertine" from *Lapis Tiburtinus*, from Tibur, an ancient town of Latium. "Tiburtine" became corrupted in time to "Travertine." This mineral occurs in several localities in California, but has not been analyzed, which leaves it in some doubt.

Thinolite is a form of calcite, a pseudomorph after Gay-Lussite, and forms in immense masses in the beds of alkaline lakes in California, Nevada, and in fact, all the great inland valley between the Sierra Nevada and the Rocky Mountains, known as the Great Basin. It was named by Clarence King, fol. 508, Systematic Geology, Vol. 1 U. S. Geological Survey of the Fortieth Parallel, and an analysis is given, fol. 823, Vol. 2, Descriptive Geology. *Thinolite* is really a tufa, being deposited in the same manner. When first found it was thought to be fossil coral, and was so described. It was first found in Mono and Owens Lakes, and in the beds of ancient lakes in the Colorado and Mohave Deserts. Thinolite from California localities is represented by Nos. 1680 and 3697, the former from Lassen County and the latter from the Colorado Desert, San Diego County.

Calcite is found in many localities in the State in small quantities, often in mineral veins with gold and ores of silver, lead, copper, zinc, quicksilver, etc., and in many varieties.

Black Calcite (2162) is found in Amador County, near Volcano; *Blue* (2004), Santa Cruz County; *Pink* (4069), Catalina Island; with quartzite (3669), Owen's Valley, Inyo County; Arenaceous, resembling the Fontainbleau mineral (3440), forty feet under the Klamath River, Thomas Middleton's Tunnel, Siskiyou County; with cuprite, malachite, and melaconite, San Amédio Ranch, Coast Range; with cinnabar (2279), Guadalupe mine, Santa Clara County, at Almaden mine, same county (1741), and at Chapman mine, same county (1224); with bitumen (1676), New Almaden; with silver and lead (2173), Modoc mine, Inyo County; with gold (4553), near Mud Springs, El Dorado County, and (4600) Palma mine, Cerro Gordo, Inyo County; and in crystals, Argus Mountains, Inyo County.

CARBONATE OF COPPER—see Malachite and Azurite.

CARBONATE OF IRON—see Siderite.

CARBONATE OF LEAD—see Cerusite.

CARBONATE OF MAGNESIA—see Magnesite.

CARBONATE OF SODA—see Natron.

CARNELIAN—see Quartz.

CAT'S EYE—see Quartz.

27. CASSITERITE. Etym. "*tin*" (Greek). This mineral is the Binoxide of Tin. $Sn\ O_2$—atomic weight, 74.

Tin	78.67
Oxygen	21.33
	100.00

It is found in nature both crystalline and amorphous. In the former state it occurs in veins intersecting granite, gneiss, mica schist, porphyry, and other rocks. In the latter condition it is found in rounded nodules or grains, from several pounds in weight to the finest black or brown sand. This is called stream tin, because it is found in placers like gold, in the beds of streams, into which it has been washed by the action of water, resulting, like placer gold, from the disintegration of rocks which contained it in veins, its great specific gravity (6.4 to 7.1) causing it to resist the force of the water which has washed away lighter minerals. Stream tin is found of various colors and texture, being black, brown, drab, or nearly white; perfectly compact and amorphous, laminated, mamillary, or botryoidal, with elevated points (toad's eye tin), fibrous (wood tin), concentric, radiated, etc. H. 6—7; luster, adamantine when crystallized, stream tin dull, nearly transparent to opaque. Tin is also found in nature as a sulphide, but is comparatively rare. It has been found also in meteoric stones.

Cassiterite is easily reduced to the metallic state in a crucible with carbonate of soda and anthracite coal dust (culm), or cyanide of potassium. The crucible should be allowed to cool, and then be broken to remove the button of tin; for this operation a hot fire is required. B. B. on ch. easily reduced if the following plan is adopted: The ore supposed to contain tin should be pulverized and passed through a 40 or 60 mesh sieve, the resulting powder washed in a pan or horn spoon to a small quantity, the *prospect* dried and ground in an agate mortar with twice its bulk of carbonate of soda. This mixture is transferred to a cavity in a piece of charcoal, and heated in the R. F. until the assay assumes a spherical form, more is added until a globule is obtained half the size of a pea; a small piece of cyanide of potassium of about equal size is then placed with it, and both strongly heated in the R. F.; globules of tin will immediately appear if the metal was present in the ore, which by a little skillful manipulation may be made to coalesce into one, or the assay may be cut out of the charcoal with a knife, and ground with water in an agate mortar, when the beads will flatten into small discs under the pestle, and may be separated by washing. To be sure that the metal is really tin, the following experiment may be made: Place the bead on clean charcoal without fluxes, and heat first in the reducing and then in the oxidizing flame. If tin it will lose its metallic character and become a white oxide, which it will be found very difficult to reduce again to a metallic globule. This may be effected by the addition of a small piece of cyanide of potassium. Observe that no distinct coating is formed on the charcoal, which would be the case if the metal were lead, remove the bead to a small anvil and strike it with a hammer until flattened out (antimony and bismuth are brittle). The button boiled in a test tube with nitric acid does not dissolve, but is changed into a white insoluble powder. Antimony gives a similar reaction, but is brittle, and on charcoal would have burned, and given off thick white fumes of oxide of antimony. These tests will serve to distinguish tin from other metals which it resembles, but another still more characteristic test may be made as follows: reduce a bead of tin from the ore, by the method above described, hammer it out very thin, place it in a clean test tube and pour hydrochloric acid over it; action takes place and the metal dissolves. Before solution is complete (a portion of the metal remaining undissolved) pour a few drops of the solution into a vessel containing a dilute solution of terchloride of gold, a purple color will be produced which leaves no doubt that the metal is really tin. These tests are described with considerable attention to detail, because tin is liable to be found in quantity in California, and it is desirable to furnish the prospector with information by which he can test the ores he may find, supposed to contain tin. It is very important to concentrate a considerable quantity of the ore, as described, for experience has shown that tin may exist in small quantities in minerals and ores, not indicated by the appearance. Great care should be observed in the use of cyanide of potassium, which is a *deadly poison.*

Metallic tin is prepared by crushing the ores and concentrating the tin mineral (black tin), roasting to drive off arsenic, sulphur, etc., and fusion in contact with charcoal, or with a flux of lime. It is purified by fusion at a low temperature, at which the tin flows, leaving impurities behind. The impurities are arsenic, antimony, bismuth, zinc, titanium, and copper. Tin is obtained pure in the laboratory by oxidizing with excess of nitric acid, and washing the binoxide so obtained, first with water, and lastly with hydrochloric acid, and afterwards fusing in closed charcoal-lined crucibles. Tin so obtained is nearly chemically pure. The specific gravity of pure tin is 7.178. It is softer than gold, harder than lead, it crackles when bent, and has a peculiar odor when warm. It has but little ductility, but considerable malleability, which is increased when the temperature is raised to 220°. It fuses at 442° F. It is distinguished from other metals by the following properties and chemical reactions:. It is *white, malleable, easily fusible*, is reduced to a white oxide by the action of nitric acid, and turns black in a solution of terchloride of gold, with excess of hydrochloric acid, without giving off gas.

THE ORES OF TIN.

The concentration of tin ores, to render them rich enough to smelt, is done by jigs, percussion tables, sluices, buddles, etc., all of which are described in works on metallurgy. Below are given the percentage yield of block tin, from celebrated Cornish mines, and the estimated value of the mines themselves:

Tincroft, $1\frac{3}{4}$ per cent block tin; value of mine, $2,100,000.
Dalcoth, $1\frac{3}{4}$ per cent block tin; value of mine, $1,790,000.
Cam Brea, $1\frac{1}{10}$ per cent block tin; value of mine, $1,280,000.

Some months ago application was made to the State Mining Bureau for the addresses of hydraulic miners competent to pipe the loose formations on the Malay peninsula for stream tin, the plan being to collect the tin as gold is collected by hydraulic washing.

Descriptions of the methods of mining and working of tin, manufacture of plate, etc., may be found in the following works, obtainable in San Francisco:

Metals; their Properties and Treatment. C. L. Bloxam.
Elements of Metallurgy. J. R. Phillips.
Percy's Metallurgy.
Encyclopedia of Chemistry. Lippincott.

USEFUL ALLOYS CONTAINING TIN.

Bronze—Copper and tin. Ancient bronze was largely copper.
Anti-friction metal, brass solder, or spelter, bronze for statues, imitation gold, button metal—Copper, zinc, and tin.
Britannia metal—Copper, antimony, zinc, and tin.
Metal for table bells—Copper, bismuth, and tin.
Speculum metal—Copper, arsenic, and tin.

Bronze for statues, bell metal—Copper, zinc, lead, and tin.
Imitation silver leaf—Zinc and tin.
Tin plate solder—Lead and tin.
Amalgam for mirrors—Mercury and tin.
Queen's metal—Lead, bismuth, antimony, and tin.
Pewter—Copper, antimony, bismuth, and tin.

One English firm requires one ton of tin per week for soldering. Tin foil, very extensively used in the arts, is generally adulterated with lead. The foil is said to be produced by preparing three sheets, one of lead and two of tin, the lead being the thickest. These are so laid that the lead plate is interleaved between those of tin. They are in this position rolled down to the thickness required, and the foil has the appearance of being tin, which it is, however, only superficially. No doubt serious trouble results at times from ignorance of this fact. At a recent meeting of the California Academy of Sciences, Dr. H. Gibbons called attention to the case of adulterated tin used in making cans for preserving fruits and vegetables, somewhat extensively manufactured in this city. The solder, also containing as it does considerable lead, should be used with caution.

Tin has been known and used from very early times. The bronze age which antedates history, succeeded the stone age, and was the commencement of the epoch of metals, the use of which followed probably in the following succession—gold, copper, tin, silver, iron. All these metals, except tin, are sometimes found in the metallic state, and from using the native metals, primitive man, without doubt, learned to reduce them from their ores. Bronze is an alloy of copper and tin in varied proportions. The alloy is better suited for universal use than either of the metals alone. The first bronze was possibly made by melting the ores of the two metals together in a charcoal fire, as we have reason to believe brass was first produced. Bronze is more fusible than copper, and makes clean castings. It is also harder than copper, and was a favorite material for the manufacture of articles of use and ornament. This alloy also has the property, probably well known to the ancients, of being, to a considerable extent, ductile when heated red hot and quenched suddenly in water. When hammered, it could be hardened by again heating and allowing it to cool slowly. It is said that the Chinese to this day make gongs and other bronze utensils by this method. It is thought by some archæologists, that all the tin used by the ancients was brought from Cornwall, which we know was the case when the Phœnicians were a great commercial nation; but bronze was used before the dawn of history in Europe, from which circumstance, a certain class of archæologists assume that ores of tin were more abundant in Central Europe, and were practically exhausted, like mines of gold, copper, lead, and other metals, celebrated in ancient history, by the drain upon them caused by the demand for the ores. It is supposed also that bronze was known, and in common use, long before pure tin and pure copper had been extracted from their ores. It is also probable, that about the commencement of European history, the ancient metallurgists and metal workers had learned to reduce the ores and make more constant mixtures by combining the two metals, as at the present time.

The Phœnicians made a great commerce of the metals which they imported from afar. Their ships sailed the Mediterranean Sea and out through the Pillars of Hercules (Straits of Gibraltar) into the

Atlantic Ocean. Thence they coasted northward along the coast of Portugal, Spain, and France, crossing the English Channel to the Cassiterides from which they obtained tin. Strabo mentions these islands. They were in the high seas, but nearly in the same latitude as Britain; these are now known as the Scilly Islands, off the coast of Cornwall. He quotes or rather refers to the writings of Posidonius: "The tin is not found on the surface, as authors commonly relate, but is dug up. It is produced both in places among the barbarians who dwell beyond the Lusitanians and in the islands Cassiterides; that from Britain is carried to Marseilles." The same author writes as follows:

The Cassiterides are ten in number and lie near each other in the ocean toward the north from the harbor of Artabri. One of them is desert, but the others are inhabited by men in black cloaks, clad in tunics reaching to the feet, girt about the breast and walking with staves, thus resembling the Furies we see in tragic representations. They subsist by their cattle, leading for the most part a wandering life. Of the metals they have tin and lead, which, with skins, they barter with the merchants for earthenware, salt, and brazen vessels. Formerly, the Phœnicians alone carried on this traffic from Gades (Cadiz) concealing the passage from every one; and when the Romans followed a certain shipmaster that they might find the market, the shipmaster of jealousy purposely ran his vessel on a shoal, leading those who followed him into the same destructive disaster. He himself escaped by means of a fragment of the ship and received from the State the value of the cargo he had lost. The Romans nevertheless by frequent efforts discovered the passage, and as soon as Publius Crassus passing over to them perceived that the metals were dug out at a little depth and that the men were peaceably disposed, he declared it to those who already wished to traffic in this sea for profit, although the passage was longer than that to Britain.

Tin is mentioned in the Bible several times and always in connection with other metals, gold, silver, iron, and lead, or in a metallurgical connection, with brass. In Numbers is mentioned tin with gold, silver, brass, iron, and lead. Isaiah 1–25, "I will turn my hand upon thee and surely purge away thy dross and take away all thy tin." Ezekiel 22–18, "They are brass, and tin, and iron, and lead in the midst of the furnace. They are even the dross of the silver." 20, "As they gather silver, and brass, and iron, and lead, and tin into the midst of the furnace, to blow fire upon it to melt it." Ezekiel 27–12, "Tarshish was thy merchant by reason of the multitude of all kinds of riches, with silver, iron, tin, and lead, they traded at thy fairs."

There are in the State Museum two objects in bronze, which possess a peculiar interest. They are both from the wreck of an ancient vessel, probably Japanese, of which there is no history. The old wreck lies outside the beach and beyond sight. The locality is the coast of Oregon, between the mouth of the Columbia River and Tillamook Bay. (1401) is a portion of a chain cable of hammered bronze; there are links and a portion of a swivel; the length of the links is 5 inches and the thickness of the metal is ¾ of an inch. (2228) is a bronze elephant washed ashore from the same wreck. The vessel was probably loaded with wax, portions of which have been washed ashore for many years. No. 2090 is a specimen of this wax found on the beach.

LOCALITIES.

Tin is comparatively a rare metal, being found at but few localities in the world. The principal countries which produce it now are Cornwall, England, Australia, Tasmania, the Islands of Banca and Billiton in the East Indies, and the Malay Peninsula. The metal is found also in small quantities at Ollenberg, Saxony; Zinwald, Bohemia; in France, Spain, Finland, Sweden, Greenland, Bolivia, Durango, Mexico; and in the United States in California, Dakota, Idaho, Alabama, Massachusetts at Chesterfield and Goshen, in New Hampshire at Lynne and Jackson, and in Virginia. As to the United States localities, the deposits of California, Dakota, and Alabama are the only ones which give promise of being valuable. The discoveries in the Black Hills, Dakota, are described as being very extensive, and if there is no mistake the supply from this locality is likely to be considerable. The tin deposits near Ashland, Clay County, Alabama, are known as the Broad Arrow mines. These mines are worked as open quarries, the ore here occurring both as lode and stream tin, all of low grade. The reduction works put up at these mines last Summer suspended operations after a few months run, and the success of the enterprise is involved in doubt. The mines of Banca were discovered by accident in 1710, and were first worked by the Chinese. In 1750 the yield was 3,870 tons. In 1817 the product was 2,083 tons, and in 1871, 4,320 tons. The ore, which is stream tin, is found from ten to fifteen feet below the surface; only a portion of the island has been prospected. Tin was found in Victoria, Australia, in 1853, by the Rev. W. B. Clark, a celebrated Australian geologist. It was afterwards discovered in New South Wales, in the New England Pastoral District, and still later in Queensland. Mr. J. Gregory reported to the Queensland Government that, having measured one hundred and seventy miles of creeks and river beds, he found on calculating the value as carefully as possible of the stream tin alone, without estimating the veins known to exist, that it amounted to the large sum of £13,000,000. The tin fields of Durango, Mexico, are known to be extensive, and it is likely that they will be washed when the systems of railroads now projected are completed. Tin has been found in at least three localities in California. In the Temescal Mountains, San Bernardino County, lies the only known deposit in the State, having a prospective value. In Plumas County, in the bed of the middle fork of Feather River, three miles above Big Bar, a single specimen was found by Mr. Thomas Lane of Laporte, and given to Professor W. P. Blake, and by him described as resembling the stream tin from Durango, Mexico. Another specimen was found some years ago near Weaverville, Trinity County, in the loose soil, and presented to Professor J. D. Whitney, then State Geologist. The vein from which it came was never found.

Grossularite, lime garnet, a common mineral in Southern California, resembles crystals of cassiterite, and has often been mistaken for it by Cornish miners. A number of reported tin discoveries have turned out to be this mineral. The Temescal tin mines are in the Temescal Mountains, whence the name. The mines are on Section 2, Township 4 south, Range 7 west, San Bernardino meridian; distant fifty-five miles east of Los Angeles, and thirty-five miles from Anaheim Landing. The ore was first supposed to contain silver, the presence of tin not being suspected.

The Temescal tin mines were discovered in 1853. Daniel Sexton and W. W. Jenkins were prospecting for gold, when they found ore that was new to them, but which they thought must contain some valuable metal, presumably silver. They brought the ore to San Gabriel Mission, and smelted it in a crucible with fluxes, in a blacksmith's forge. The contents of the crucible were poured out on the face of the anvil, when a piece of white metal (two inches long, and three quarters of an inch wide, thin at one end) appeared, which was, without doubt, the first piece of metallic tin produced in the State. Under the impression that it was silver, Mr. Jenkins took it to Los Angeles, and showed it to N. E. Drown and Major Henry Hancock, United States Surveyor, when it was found to be tin. They proposed to demand from the United States Government the reward supposed to have been offered for the discovery of a workable tin mine within the borders of the Union. Major Hancock endeavored to obtain a claim to the tin mine, which was found to be on the Temescal Rancho, supposed to be owned by Mrs. Josefa Montalva. Mr. Jenkins, at the request of Major Hancock, sent for her to come to Los Angeles, to execute a deed to the Major. When she arrived, she informed the Major that Don Abel Stearns and Requena were her good friends, and declined to convey. She afterwards disposed of her interest to Abel Stearns. In 1860–1 the locality was a scene of great excitement. Five hundred claims were located on the mineral belt.

A close corporation was formed, to which Mr. Stearns leased the property. Phelps, Dodge & Co., of New York, owned nine twentieths; S. C. Bruce, of California, eleven twentieths. Mr. Bruce commenced opening the mine September 27, 1860; erected buildings and sunk shafts ninety-five feet, when the civil war broke out, and all operations ceased till peace should be declared. The San Jacinto Tin Mining Company was organized January 2, 1868, with a capital stock of $4,000,000. The object of the company was to acquire Rancho Sobrante de San Jacinto, a Spanish grant of eleven leagues, or about 49,000 acres of land, supposed to cover the tin mines. The grant was confirmed, and a patent issued by the United States Government October 26, 1867. On the twenty-fourth day of June, 1868, the company took possession of the property, and on the twenty-seventh day of the same month and year work was resumed on the Cajalco mine, the same which was opened by Mr. Bruce in 1860. Mr. E. M. Robinson was Superintendent for the new company. Samples of the tin, tin plate with vessels made from it, and samples of the ore, were exhibited in the Mechanics' Institute Fair, at San Francisco, in 1869, winning for the company the Gold Medal. The bars of metallic tin then on exhibition are now in the Museum of the Pioneer Society. Of the ore there are fine specimens in the State Museum, represented by the catalogue numbers (134) and (235), the former from the Cajalco mine, and the latter from the San Jacinto mines. Specimens were shown at the Paris Exposition of 1878, and donated after the Exposition to the French Government, with many other California ores and minerals. They are now in the Ecole des Mines, in Paris.

The ores are very deceptive to the eye. No mineralogist, no matter how familiar he might be with other ores of tin, would recognize these by sight alone. They present a brown lusterless appearance, with spots of yellowish-brown. When concentrated by washing, the heavy powder which results may be readily distinguished by the microscope as cassiterite. The following is an analysis of the ore from these mines, by Professor F. A. Genth of the University of Pennsylvania:

Silicic acid	9.82
Tungstic acid	.22
Stannic acid	76.15
Oxide of copper	.27
Oxides of iron, manganese, magnesia lime, and alumina	13.54
	100.00

The stannic acid in the above analysis is equal to 59.92 per cent of metallic tin. The tin reduced from the ore yielded by analysis:

Metallic tin	99.78
Iron	11
Copper	11
	100.00

"The ores are found in mica slate, gneiss, and granite, and associated with iron, antimony, arsenic, and gold ores, in a gangue of quartz, fluor-spar, apatite, and baryta."—[Report of Company.] The Temescal River skirts the southwest boundary line of the property of the company, and the Santa Ana River flows but a few miles to the northwest; both streams furnish ample water-power for a portion of the year. Cornish miners and experts, and skilled mineralogists from various parts of the world, have examined these mines, and have pronounced favorably upon them. One who had large experience in the stannaries of Cornwall thought there was enough eight per cent ore in sight to make 600 tons of pig metal. Mr. William Williams, formerly employed in the mines, and whose statements appear in the reports of the company before referred to, told the State Mineralogist that it was a good mine and only required development to produce profitable returns. There are conflicting titles to these mines. The representatives of Abel Stearns are in litigation to recover possession. There is reason to hope that tin will become in the future one of the commercial products of the State.

PRODUCTION.

The world's production of tin in 1873 was estimated at 25,000 to 28,000 tons. In 1883 it was 45,770 tons. The product from 1878 to 1881, inclusive, is estimated at 147,553 tons. The United States uses more tin and tin plate than any other country, estimated at one third the world's production of this metal. It may be seen from this how important it is to develop any mines that we may have within our borders.

IMPORTS.

About 243,000 tons of tin plate are imported into the United States annually. In 1871 England exported 120,000 tons of tin plate, of which 67,140 tons were sent to the United States. From 1872 to 1882, inclusive, the United States imported of block tin 87,941 tons, valued at $41,293,644, and during the same time 1,500,329 tons of tin plate, valued at $159,035,810. The following is a table of Australian tin received at San Francisco:

Year.	Pounds.	Year.	Pounds.
1875	262,528	1880	764,060
1876	482,608	1881	1,495,088
1877	588,672	1882	1,834,320
1878	625,080	1883	1,298,209
1879	637,392		

Keeping pace with the growth of our canning industries, future requirements will increase year by year, the same being true all over the country. Among our most stringent wants are, therefore, largely productive tin mines. There is a widespread belief that at some time in the past the General Government has offered a large sum as a bonus to any person who should find a productive tin mine in the United States. The sum has been stated at from ten to two hundred thousand dollars. The Legislature of California has been reputed to have offered also a large sum for such a discovery. There is no truth whatever in such statements, although so generally believed.

CAT'S EYE—see Quartz.

28. CEMENT.

The mineral cements are nearly all artificial, and are made of lime and sand (mortar), calcined hydraulic limestones, or dolomites, to which certain ingredients are sometimes added. Pozzuolana (described under the head of building stones), plaster of Paris, concretes, etc., which will be found described under the various heads.

29. CERARGYRITE. Etym. "*Horn Silver*" (Greek).

This mineral is a chloride of silver (Ag. Cl). Composition as follows:

Chlorine	24.7
Silver	75.3
	100.0

Color pale yellow, gray, or green, nearly white. Luster resinous, appearance like wax; can be cut with the thumb nail, the cut having a shining luster. Sp. gr. 5.31 to 5.55. In closed tube melts, but is not decomposed. On ch. B.B. with carbonate of soda, a bead of silver is easily reduced. Another blowpipe test is made by melting a small portion of *pure* microcosmic salt in a loop of platinum wire, which is saturated with oxide of copper by dipping it into the vessel containing the oxide and again heating. If a small fragment is now added to the bead of prepared flux, and still again heated before the R. F., a distinct azure blue color will be imparted to the flame (chlorine). Cerargyrite is not soluble in nitric acid, but ammonia dissolves it wholly, and from the solution the chloride of silver is precipitated by neutralizing the ammonia with an acid. As cerargyrite is generally disseminated in the ore in such small particles, or crystals, as to be generally invisible to the unassisted eye, the latter plan is the best to detect it. The ore is first pulverized, and placed on a filter and leached with ammonia, which is then filtered and treated with the acid. If cerargyrite is wet with water slightly acidulated and laid on a piece of sheet zinc, it turns black and is soon reduced to metallic silver, which becomes bright and metallic if rubbed hard in an agate mortar. Cerargyrite is rather a common mineral in some of the southern counties of the State, associated with embolite, but seldom in masses sufficiently large to form good cabinet specimens. Microscopic crystals of great beauty are not uncommon, but the mineral generally occurs in very thin crusts. (4912) and (5158) are from

Slate Range, Inyo County. The finest microscopic crystals are found in the Modoc Chief mine, Inyo County. Cerargyrite is a valuable silver mineral, and is easily reduced by the most simple metallurgical process.

30. CERUSITE. Etym. *Cerussa* (Lat.). White Lead, Carbonate of Lead, White Lead Ore, etc. PbO, CO_2.

Carbonic acid	16.5
Oxide of lead	83.5
	100.0

Equivalent of metallic lead 77.5 per cent; color, white, gray, nearly black; transparent, sub-translucent to opaque; brittle, H=3–3.5; sp. gr. 6.46–6.48; B B on ch. fuses, and in the R. F. yields a bead of lead, coating the charcoal at the same time yellow. Dissolves in nitric acid, with effervescence. This mineral is very easily distinguished, and is rather common in California, seldom in crystals, but generally associated with galena, anglesite, azurite, chrysocolla, malachite, silver minerals, and gold. Fine crystallized specimens, with the associates above mentioned, are found in the Modoc mine, and in many other localities, in the Inyo and Coso Mountains, Inyo County; in the Russ district, in the same county, in large crystals resembling those from Siberia, and at Great Basin mine, near Mohave River (Blake). It is a valuable ore of lead, and in certain localities an indication of silver ores. A considerable proportion of the lead ores worked at the Cerro Gordo mines were cerusite. Thirty-two thousand tons of lead were produced in these mines during the time in which they were worked.

31. CERVANTITE. Etym. "*Cervantes*" (Span.). Antimony Ochre.

This is a rare mineral in California. It occurs with Stibnite in San Amedio Mountain, Kern County. (Blake.)

32. CHALCANTHITE. Etym. "*Flowers of Copper*" (Greek). Native Sulphate of Copper, Blue Vitriol.

This results from the decomposition of copper sulphide ores (see copper) and is rare in nature. At the Rio Tinto mine in Spain the waters contain so much of this mineral in solution that they are collected and the copper precipitated by iron, yielding cement copper in considerable quantities. It sometimes occurs in old copper mines in California when the waters do not flow from the workings, and old tools such as picks, gads, hammers, etc., left by accident in the old works, have been found changed to metallic copper, or to be very heavily coated with that metal. Specimens in the State Museum are from the Peck mine, Copper City, Shasta County, and from Sweetland, Nevada County.

The waters of a copper spring near Glenbrook, Lake County, deposit copper on a knife blade.

Chalcedony—see Quartz.

33. CHALCOPYRITE. Etym. "*Copper Pyrite*" (Greek). (See, also, Copper.) Copper Pyrites.

This mineral is a double sulphide of copper and iron:

Sulphur	34.9
Copper	34.6
Iron	30.5
	100.0

Color, brass yellow; opaque. Occurs both crystallized and amorphous; the latter generally mixed with other minerals. On ch. B.B. generally decrepitates, gives off fumes of sulphur, and fuses to a magnetic globule. If this is wet with hydrochloric acid, a blue color is imparted to the blowpipe flame; with fluxes, a bead of copper is obtained. The pulverized mineral dissolves in nitric acid, giving off red nitrous fumes; the solution is green, but if neutralized with ammonia becomes intensely blue. If the nitric solution is evaporated to dryness and redissolved in hydrochloric acid the whole of the copper will precipitate if a piece of iron or zinc is placed in the solution; the precipitation is accelerated by the application of heat. This mineral is quite abundant in California, being found in greater or less quantities from north to south. It is a valuable ore of copper, but its metallurgy presents so many difficulties that it is found generally more profitable to concentrate it and ship it to England than to work it here. Under some circumstances it has been found economical to reduce it to a matte by a single furnace operation, and ship it in that condition. It is also worked somewhat extensively at Campo Seco, Calaveras County, and at Spenceville, Nevada County. The following California localities are represented in the State Museum: (3017.) Campo Seco, Calaveras County. (4119.) Beveridge District, Inyo County. (4137.) Lexington, Santa Clara County. (4247.) San Diego County (in steatite). (4274.) Stony Creek, Colusa County. (4387.) Spenceville, Nevada County. (4485.) Bullion District, Plumas County.

Chalcopyrite is common in ores containing gold, all over the State. It occurs with erubescite and pyrite at Copper City, Shasta County; at Copperopolis and Lancha Plana, Calaveras County; in specks in the jaspers in San Francisco County; Light's Cañon, Plumas County (Blake); near Hornitos, Mariposa County; in the rocks of Mt. Diablo (Blake); in Los Angeles, San Bernardino, and San Diego Counties; the Inyo and Coast Range Mountains; in fact, it is almost universal in its distribution over the State.

34. CHALCOSITE. Etym. *Copper* (Greek). Vitreous Copper, Copper Glance.

This mineral is a sulphide of copper (Cu_2, S).

Sulphur	20.2
Copper	79.8
	100.0

Color, dark lead-gray, often green on the surface. Luster metallic, H.=2.5—3.0. Sp. gr.=5.5—5.8. B.B. on ch. melts and gives off fumes of sulphurous acid, and with fluxes is easily reduced to a bead of copper. Soluble in nitric acid; the solution gives similar reactions to those described under the head of Chalcopyrite. It is found with other ores of copper in the State, more frequently in the southern counties. It is sometimes argentiferous, and merges into Stromeyrite, which see. It occurs in the silver ores in Inyo and San Bernardino Counties; in Genesee Valley (in basalt), Plumas County (Edman); in San Diego County; in Los Angeles County; at the Maris mine, in grains and irregular masses, in syenitic granite, containing silver (Blake); and in San Luis Obispo County. No. (4486) is from the Enterprise mine, Bullion District, Plumas County.

Chessy Copper—see Azurite.

Chloride of Silver—see Cerargyrite and Embolite.

Chloro-Bromide of Silver—see Embolite.

Chloro-Carbonate of Lead—see Phosgenite.

Chrome Iron—see Chromite.

35. CHROMITE—Etym. "*Color*" (Greek). Chromic Iron, Chrome Ore, etc.

Chromic iron is the ore from which all the salts of chromium are obtained. It is a dense, heavy, dark colored mineral, which is usually compact, although sometimes granular. Its sp. gr. is from 4.34 to 4.498. It is hard enough to scratch glass. Its streak and powder are brown, even if the mineral is black. Before the blowpipe it is infusible alone, but with borax it slowly melts, forming a characteristic green glass. It occurs in serpentine rocks in irregular masses, rarely in veins. Serpentine and several varieties of marble, especially "verde antique," owe their beautiful green color to the oxide of chromium. The emerald is also indebted to this mineral for its charming color. Chromic iron is seldom found pure. When crystallized its composition is expressed by the formula, $FeO\ Cr_2\ O_3$. The mean of ten analyses of samples from different localities was found to be·

Protoxide of iron	27.53
Magnesia	6.50
Alumina	9.57
Sesquioxide of chromium	53.62
Silica and loss	2.78
	100.00

The metal chromium was discovered by Vanquelin in the year 1797. As early as 1766 Lehmann wrote a letter to Buffon giving a description of a new mineral of a bright scarlet color which was found in a mine in Siberia. Pallas, the celebrated naturalist, believed it to be a compound of lead, arsenic, and sulphur. The most celebrated chemists of the period attempted to analyze it, but the results obtained differed so widely that much was said and written upon the subject. In 1797 Vanquelin made a critical examination of it, and found it to be oxide of lead, combined with an acid having a metallic base which was new to science. He afterwards succeeded in reducing the metal and produced *chromium*, so named from the Greek word signifying color. The red mineral which led to this discovery was chromate of lead, now known by the name of "Crocoisite."

Metallic chromium may be reduced from the oxide by subjecting it with charcoal to an intense heat. It is a metal possessing a color between that of tin and steel. Its specific gravity is 5.9. It is nearly infusible, does not oxidize in the air, is not magnetic, or only slightly so; and very brittle. It is scarcely acted on by nitric, hydrochloric, or nitro-hydrochloric acids, but dissolves in hydrofluoric acid with evolution of hydrogen. Chromium is also reduced by galvanic electricity; by adding sodium amalgam to a solution of chloride of chromium an amalgam of chromium is produced which is distilled, leaving the metal in a pulverulent state; and by heating the oxide in a porcelain tube in an atmosphere of hydrogen into which vapors of sodium are admitted. The reduced metal is found to be in the form of crystals. The metal fuses with great difficulty, and is non-volatile. In the metallic state no use has yet been found for it in the arts.

CHIEF USE OF CHROME ORES.

The chief use of chrome ores is the production of the beautiful salts known in commerce as the chromate and bi-chromate of potash, which are used principally in dyeing and in the manufacture of pigments. Treated in a large way, the ore is crushed under heavy edge-wheels, and then bolted. It is essential to the success of the operation that the minutest division is effected. The pulverized ore is then mixed with half its weight of nitrate of potash, and subjected to a high heat for several hours on a common reverberatory hearth. During the process the mass is occasionally stirred. When the proper time has arrived, the whole is raked out and a fresh charge introduced. The fused mass is allowed to cool, and is then lixiviated with water. The yellow solution is concentrated by evaporation and allowed to crystallize. The resulting salt is "chromate of potash." To obtain the bi-chromate, which is most used in the arts, the concentrated solution is treated with a strong acid—either nitric, hydrochloric, or acetic. The acid combines with the second atom of potash, leaving the bi-chromate in solution, which may be crystallized out in the usual manner.

These salts are extensively used in dyeing. To dye yellow, the material is first passed through a solution of acetate or nitrate of lead, and then through one of bi-chromate of potash, by which chromate of lead is formed, which is yellow. If it is desired to dye a fabric *green*, it is first dyed blue, and then yellow as above, by which combination green results.

Orange is produced by dyeing yellow, and then passing the material through a boiling solution of caustic lime, by which the orange sub-chromate of lead is formed. Bi-chromate of potash is also used to give a brown color, by being used with catechu, by which a great variety of brown, drab, and fawn colors are produced. This salt is used in the manufacture of ink. There are said to be six chemical works in which bi-chromate of potash is produced—three in Glasgow, Scotland, and one each in Russia, Austria, and the United States.

Bichromate of Lime.—Finely powdered chrome iron is intimately incorporated with chalk. This mixture is exposed in a layer one and a half inches thick for ten hours in a reverberatory furnace. The product is chromate of lime, difficultly soluble by grinding while suspended in water with a slight excess of SO_3. To separate any protosulphate of iron present, milk of lime is added; the clear layer consists of bi-chromate of lime in solution.

There is a specimen of Aragonite in the State Museum No. (3602) that might be used as a substitute for chalk.

Chromic Acid ($Cr\ O_3$) forms prismatic crystals of a dark ruby red color, which are deliquescent and color the skin yellow. When it is heated to redness, or parts with one equivalent of oxygen, it becomes the green protoxide. When its solution is neutralized with ammonia it is changed into the sesquioxide with energetic chemical action. It dissolves in alcohol, from which crystals of the green oxide gradually deposit. The aqueous solution of chromic acid is decomposed by the sun's rays, oxide of chromium being precipitated. If chromic acid, obtained by decomposing chromate of baryta with sulphuric acid, or four parts of chromate of lead, is mixed with three parts of finely powdered pure fluorspar freshly calcined, and five parts of concentrated sulphuric acid, placed in a still of platinum, or lead, and gently heated, a red vapor passes over which is condensed into distilled water contained in a vessel of platinum, and a dark orange colored liquid results. The vapor (fluoride of chromium) decomposes in the water to hydrofluoric and chromic acids. The liquid evaporated in the platinum dish becomes pure chromic acid. Chromic acid is generally made by mixing a solution of bichromate of potash with a large quantity of strong sulphuric acid; as the mixture cools, crimson red crystals of chromic acid form; these are washed with strong nitric acid and dried. The proportions used are 100 volumes of cold saturated solution of bichromate of potash and 150 volumes of strong sulphuric acid. The acid must be added in small successive portions. Chromic acid forms salts with numerous bases. The resulting chromates are all red or yellow, and are usually soluble in water.

Sesquioxide of Chromium ($Cr_2\ O_3$) is obtained by igniting chromate of mercury, or by calcining a mixture of equal parts of flour sulphur and pulverized bichromate of potash in a closed earthern crucible, and washing the green residue with hot water to remove the sulphate of potash. The thoroughly washed residue is dried at a water-bath heat. After exposure to a red heat it resists the action of acids. It is converted into chromic acid by deflagation with nitrate of potash.

Hydrated Oxide of Chromium is precipitated from acid solutions by alkalies in the form of a voluminous green powder. It may be obtained by adding a mixture of equal parts of alcohol and hydrochloric acid portionwise, to a boiling solution of chromate of potassa; the liquid becomes pure green in color. When cold, an excess of ammonia is added, which precipitates the hydrated oxide, in which state it is soluble in acids.

It may also be prepared as follows: Mix chromate of potassa with half its weight of chloride of ammonium; heat the mixture to redness, and wash the resulting mass with excess of boiling water.

Oxide of Chromium is used in the arts as a pigment—in glass staining, in painting on porcelain, and in producing artificial gems. It is also now extensively used in printing United States currency—"greenbacks." It is a lively green-colored powder. It is so expensive that it cannot be generally used, although it is the only permanent green pigment known to the chemist. An artificial gem, almost equal to the emerald, is made by fusing together: Fused boracic acid, 4.06 parts; silica, 7; alumina, 1.60; glucina, 1.40; oxide of chromium, 0.10.

A beautiful green aventurine glass has been made by M. Pelouze, composed as follows:

Sand	250 parts
Carbonate of soda	100 parts
Carbonate of lime	50 parts
Bichromate of potassa	40 parts

This glass melts with difficulty. It is described as being of "a deep green color, and full of small spangles—crystals of oxide of chromium—which sparkle with a brilliancy inferior only to the diamond." Chromic iron has within a few years been put to a new use. It is now melted with ordinary iron, forming an alloy of iron and chromium, which is harder than iron, and has a kindred use as a substitute for steel in certain cases. The following is translated from a French pamphlet, published in Paris, in 1878:

REMARKS ON CHROME STEEL.

By M. G. Rolland, Mining Engineer.

Products known of late years in metallurgy as chrome steel have excited a great interest; they are extremely hard, and remarkably resistant to traction. These species of steel contain a few tenths per cent of chrome. The chrome has the property of greatly increasing the hardness and resistance of the metal, but it has no tempering properties, and could not, as it is sometimes said, take the place of carbon and replace it. Mr. Boussingault melted a mixture of iron, of four per cent of carbon and oxide of chrome combined, in such proportions that the oxygen of the former would exactly consume the carbon of the latter; the residue obtained was an alloy of non-carbureted iron and chrome, which could not be tempered.

Berthier is the real inventor of chrome steel. As early as 1821 he was conversant with the way of "introducing chrome into cast-steel," and said that "steel alloyed with chrome possessed properties which could make it very useful in many instances."

I quote the following extracts from Berthier's works on "Combinations of chrome with iron and steel," published in 1821, in the "Annales des Mines," first series, vol. 6, page 573, and the "Annales de Chimie et de Physique," second series, vol. 17, page 55:

"To prepare with an ore of the nature of that of the Island of the Vaches (chrome iron, containing 0.370 of peroxide of iron, 0.360 of oxide of chrome, 0.215 of alumina, 0.050 of silica), which is a mixture very rich in chrome, it is necessary to melt this ore in a crucible of damp charcoal, with 0.30 of lime and 0.70 of silica, or with 1.00 of vitrified borax; and to extract the greatest quantity possible of chrome from this ore, it will be necessary to add a certain quantity of oxide of iron to the flux. It is evident that the quantity of flux employed will vary with the quantity of alumina contained in the ore, and that the smallest quantity of it must always be used—borax by economy and to decrease volatilization, and glass or silica flux because it stops the reduction of the oxides which are combined with them. The Philadelphia ore (chrome iron containing 0.372 of peroxide of iron, 0.516 of oxide of chrome, 0.097 of alumina, 0.026 of silica) would easily melt with 0.14 of lime and 0.32 of silica; or with 0.50 of alkaline glass, or also with 0.16 to 0.20 of vitrified borax, it would give a much larger proportion of alloy than that of the Island des Vaches, and this alloy would contain much more chrome."

If I have given extensive explanations on the manner of preparing economically alloys of iron and chrome, it is not because I think that these alloys can of themselves be of great use, but because it is probable that they will be used to introduce chrome into cast-steel. The idea of introducing chrome into cast-steel was suggested to me by the lecture on Mr. Faraday's works on "Alloys of Different Metals With Steel." I found that steel, combined with chrome, had properties which could make it useful in many instances.

I made two alloys of cast-steel and chrome, one containing 0.01 of chrome and the other 0.015. I prepared the "chrome steel" by melting best cast-steel, pounded into small pieces, with an alloy of iron and chrome. This is the way to proceed when manufactured in large quantities.

Chrome steel is manufactured at this time to my knowledge in the United States at Brooklyn, New York (Chrome Steel Company), in England at Sheffield, and in France at Unieux, Loire (Holtzer Steel Company).

Having visited in 1876 the Brooklyn foundry, I will briefly state the mode of manufacture and qualities of its products. This pamphlet contains not only the information obtained by me in America, but also the analysis and information of Mr. Boussingault, who kindly helped me in this work by his valuable information.

Mr. Boussingault will shortly publish an account on chrome iron and chrome steel, and on the different processes of dosing the chrome.

The manufacture of chrome steel in Brooklyn, though it is kept very quiet, is only an application of Berthier's process. The chrome iron ores used in that foundry come from Baltimore, and have varied as to their composition; some contained 13 per cent of alumina, and 11 per cent of silica; others as much as 60 per cent of oxide of chrome and no silica. The ore, pulverized and mixed with pulverized charcoal and a suitable flux, is reduced in graphite crucibles; the production is a white chrome iron, similar to Berthier's alloy of iron aud chrome. It is called "Ferro-chrome," by analogy with the "Ferro-manganese." Ferro-chrome of Brooklyn, analyzed by Mr. Boussingault, indicated 4.25 per cent of combined carbon, and 48.70 per cent of chrome.

The Ferro-chrome from Unieux contains about 5.4 per cent of combined carbon, and as much as 67.2 per cent of chrome.

Chrome is accidentally found in certain iron smeltings. A few tenths per cent have been found in iron smeltings in Russia. Mr. Boussingault found 1.95 per cent or more of it in the white iron smeltings of Medellin, Province of Antioquia, South America, which are remarkable for their hardness.

Chrome steel is obtained afterwards by melting in a crucible (in a Siemeus furnace of 24 or 32 crucibles) fragments of best iron or steel from America, Sweden, or Norway, with an addition of ferro-chrome, calculated according to the desirable degree of temper or hardness. Mr. Boussingault found, in a piece of hard steel manufactured in Brooklyn, 1.10 per cent of combined carbon, and 0.44 per cent of chrome.

The chrome steel from Unieux is manufactured in a similar way as that of Brooklyn. The quantities of chrome vary between 0.5 per cent and 0.9 per cent; the proportions of silicon and manganese could be easily omitted.

The Chrome Steel Company manufactures three principal qualities of chrome steel. No. 1 is the hardest, and is used for tools, drills, and planing machines for working hard substances, such as the shell-off of cast iron; No. 2 is used for tap-borers, punches, and jewelers' rollers; No. 3, called the universal number, for scissors, drills, and all sorts of tools to cut substances of medium hardness. There is also a No. 1 extra hard, for choice tools; and a No. A, softer than the No. 3 (which does not temper), and preferable for certain other tools, such as hammers of superior quality, gun barrels, etc.

At Unieux very hard chrome steel is mostly manufactured; this is used for choice tools; they have also tried to manufacture there pieces of artillery tubes of chrome steel, containing 0.6 to 0.7 per cent of combined carbon, and about 0.58 per cent of chrome.

When tapped chrome steel is generally less liquid than ordinary steel. The unwrought bar when hot, or after being heated again, is first roughed down with a stamp hammer, heated again and then brought down to the desired shape or size by hammering or rolling.

The bars or manufactured articles are always small in size. It seems that large pieces of chrome steel are not easily worked, probably because they are less homogeneous after cooling.

According to Mr. Julius Baur, chrome steel does not deteriorate when submitted to a high temperature (except a superficial oxidation); at Brooklyn the metal is boldly heated to the highest temperature before it is worked, except for punching, which is done at a medium heat. Mr. Julius Bauer says, also, that chrome steel is more easily welded, either to itself or to iron, than common steel.

On the contrary, Mr. Ridley having puddled common gray iron smeltings with an addition of chrome smeltings, found that the chrome smeltings increased the length of the puddlage, and that whatsoever was the quantity added, the oxide of chrome that resulted made the scoria thicker and the welding of the iron more difficult. There was a little chrome left in the wrought iron, but its influence, either good or bad, was worth little notice.

At Brooklyn the Nos. 2 and 3 are prepared for welding purposes.

Chrome steel is particularly hard to temper, and for that reason must be heated at the lowest possible temperature to the cherry red color, which is sufficient for it to be tempered. It is necessary to let it cool after it has been hammered, and heat again before tempering all tools coming from pieces relatively large and having thin edges, because, if the tool was plunged into water, or any other cold bath, the inside of the piece which cools slower than the outside would be tempered too hot, and would be apt to crack.

The following is a simple way of ascertaining the temperature at which it is proper to temper chrome steel. The end of a bar is placed in a furnace and heated; it is after removed, and the different degrees of heat are taken on several parts of the heated portion, and then plunged into cold water. After cooling, the bar is broken into small pieces by striking it on an anvil. If the end of the bar was too hot, the grain of breakage will be at first coarse, but will gradually decrease at the spot where the heat of the bar was of a dark red color; the grain will then become finer and more fibrous, the steel being harder, stronger, and less brittle than in the spots which had been more heated. The spot where the steel shows a fine and fibrous grain was at the suitable temperature.

The Chrome-Steel Company claims exceptional qualities for its steel. Cold, its tractive power would be greater than any other steel; tempered, it could not be drilled by any other steel, and would perforate any other steel containing an equal quantity of carbon. Experiments have been made at the West Point foundry on the tractive power of American steel containing chrome manufactured at Brooklyn; they were of different degrees of hardness—some hot, others cold (specific gravity 7.8161 to 7.8536), maximum charge of rupture 139 kilogrammes 84 hundredths per square millimetre; minimum charge 115 kilogrammes 13 hundredths.

The greatest tension of rupture of steel bars given by the metallurgical works of Percy, is of 107 kilogrammes per square millimetre at the section of rupture. (Cast-steel for tools of Torton.)

The Chrome-Steel Company made a very interesting exhibit at the Philadelphia Centennial

Exposition. It consisted of chrome ore, ferro-chrome, chrome-steel in bars and in tools of different shapes and sizes, bars twisted and bent when cold, etc.; also steel plates for safes, etc., in sheets of chrome steel and iron welded together and tempered (chrome steel cannot be perforated by ordinary tools—the iron remains ductile and does not break with a blow), safety bars for prisons, banking houses, etc.; also manufactured with chrome steel and iron welded together and tempered, they can neither be sawed nor broken; beams of chrome steel and iron of all shapes welded together. This combination adds to the strength and reduces the weight.

Many parts of the large metallic bridge on the Mississippi River, at St. Louis, are of chrome steel; but in this case I do not think that the use of chrome steel was necessary.

Before ending, I must say that in America, as well as in Europe, chrome steel is generally not much known, and has had, up to this time, more detractors than partisans. It certainly has many great qualities which make it very useful in many special cases, and which will keep it from disappearing; but its application is too limited for it to be manufactured on a large scale.

According to Mr. Sergius Kern, of St. Petersburg, a new process of chrome steel manufacture has been tried at the Oubouchoff steel foundry, in Russia. The process consists in melting in refractory clay crucibles a mixture of pounded Bessemer or Siemens-Martin steel and iron, or refined iron smeltings, according to the degree of steelness wanted, in subordination of an addition of chrome iron and limestone, roasted and pounded beforehand (these placed in the bottom of the crucible). Mr. Kern does not say if the new process has in view the introduction of chrome in steel; he only insists on the two following points:

1. Benefit of employing chrome iron instead of ferro-manganese, frequently used in our days as a reducer; but the price of ferro-manganese is high, and it makes the steel phosphorous and sulphurous.

2. Benefit in using Bessemer's and Siemens-Martin's steels, which are manufactured at present at little cost and with great care, instead of steel bars puddled with wood, which are always expensive, and are never uniform as to their amount of carbon. In these experiments a lot of cast-steel was manufactured, in which the amount of combined carbon varied from 0.20 to 1.30 per cent, and the amount of chrome from 1.01 to 0.25 per cent. These sorts of steel have been classified in four numbers. The average amounts of carbon are: 0.25, 0.49, 0.95, and 1.20 per cent. Experiments on tractive power were made on bars hammered first and hammered after; the average weights of rupture, resulting from six experiments for each number, are for: No. 1, of 75 kilogrammes, 75 hundredths for each square millimetre; No. 2, of 77 kilogrammes, 49 hundredths for each square millimetre; No. 3, of 82 kilogrammes, 37 hundredths for each square millimetre; No. 4, of 86 kilogrammes, 15 hundredths for each square millimetre.

The salts of chromium, as before mentioned, are extensively used in dyeing and in the manufacture of pigments.

Chrome yellow, or chromate of lead, occurs in nature as red lead ore or crocoisite, but has not been found in California. The pigment, under the same name, is prepared artificially on a very large scale.

There are two varieties of chrome yellow, named technically, "lemon" and "orange." They are prepared as follows:

The lemon chrome is known under the various names of Paris, Leipzig, Gotha, Hamburg, Cologne, Imperial, Citron, and New Yellows; but they are all prepared in a similar manner, with certain minor differences.

This beautiful color is made by adding a solution of chromate of potassa to one of nitrate or acetate of lead, and washing and drying the precipitate on a filter. Light lemon chrome is made by adding sulphuric acid or solution of alum to the chromate solution, before pouring it into the solution of lead. Bichromate makes a deeper shade of yellow.

The following formulæ are modifications of the above:

Twelve and one half pounds of bichromate of potash dissolved in twenty-eight and one half gallons of water, precipitated with solution of nitrate of lead, yields fifteen and one half pounds of chrome yellow. In theory fifteen pounds bichromate of potassa, and nineteen pounds acetate of lead, yield twenty-one pounds chromate of lead—but these results are not obtained in practice.

In making canary yellow, using the same solutions, care is taken to pour the nitrate of lead solution into that of the chromate, and never the reverse.

Sulphur Yellow.—Five pounds chromate of potash dissolved in two hundred pounds of water, add eight pounds sulphuric acid 66° B., and pour in solution of nitrate or acetate of lead as long as a precipitate falls.

The following recipe is given for making chrome yellow from sulphate of lead:

Mix 100 pounds of litharge with 10 pounds common salt and add warm water sufficient to make a paste. In twenty-four hours the mixture begins to rise; stir well, and should it have thickened by the operation, add water sufficient to reduce it to its former consistency. Repeat daily until the operation is finished, which is known by whitening of product. At a temperature of 20° to 24° C. the operation completes itself in 45 days; when all is changed to chloride of lead, add 12 pounds of nitric acid. Stir well and leave it a few hours, and add a saturated solution holding 15 pounds of alum. Stir well once more, chloride of lead is thus changed to sulphate. After several hours add the sulphate of lead, without removing the mother liquors, to a solution of bichromate of potash, 1 pound of the salt to 15 pounds water. If a light shade is required, pour chromate solution, when cold, in a thin stream, stirring well. To make orange *hot* solutions are necessary. An orange shade is produced by substituting carbonate of soda for the alum. Subchromate of lead, orange chrome, is made by pouring together solutions of bichromate of potash and subacetate of lead. Subacetate of lead is made by boiling litharge and solution of acetate of lead together. The following recipe gives a deep chrome red or orange almost equal to vermilion by actual experiment: 4 pounds dry white lead, 1 pound bichromate of potash, 20 pounds water (or larger quantities in the same proportion); boil together until the solution is colorless. The liquid is drawn off and the pulp well mixed—best by grinding in a paint mill.

Theoretical reactions in the production of chromates of lead from carbonate of lead.

Chromate of Lead.—$2\,(PbO, CO_2)\ (267.14) + (KO, 2\,CrO_3)\ (148.51) = 2\,(PbO, CrO_3)\ (324.54) + KO\ (47.11) + 2\,(CO_2)\ (44)$.

Sub-Chromate of Lead.—$4\,(PbO, CO_2)\ (534.28) + KO, 2CrO_3\ (148.51) = 2\,(2PbO, CrO_3)\ (547.68) + KO\ (47.11) + CO_2\ (88.)$

Orange chrome, when well prepared, is a dense beautiful pigment, which is obtained of various shades, from light orange to the deepest red, by modifying the solutions. It has remarkable staining properties; that is to say, it imparts its color to a large quantity of white lead or other paint. It covers well, but is subject to the same changes from foul gases and sunlight, which make all lead pigments objectionable. Sulphuretted hydrogen, which forms a part of sewer gases, common illuminating gas, and bilge water, turn it black (sulphide of lead), but with all these objections it is extensively used and could hardly be dispensed with by the painters. The light chrome yellows are rather difficult to produce as the solutions are apt to become basic. This may in part be avoided by leaving the precipitate for some time in a dark place. The yellow pigments are often adulterated, sometimes as much as 50 per cent; generally with whiting, but often with sulphate of lead, white lead, clay, sulphate of baryta, ochre, gypsum, oxide of zinc, etc. These factitious materials are stirred in while the precipitations are being made. Pure chromate and sub-chromate of lead are perfectly soluble in nitric acid *without effervescence.* Sulphates of lime, lead, and baryta remain undissolved. It is also soluble in potassa. It gives a green solution with HCl, leaving a white residue of chloride of lead, soluble in excess of water. With caustic soda becomes orange on boiling and forms a yellow fluid with no residue if pure. On ignition becomes reddish brown; gives beads of lead with soda on charcoal. It is poisonous. A good method of testing the chromate it contains is to make a lead crucible assay and to calculate the percentage of lead that ought to be present in the pure pigment.

Light chrome yellow may be changed to orange by digesting it with solution of bichromate of potash.

Chromate of zinc and chromate of baryta are sometimes used as pigments. They have the advantage of not being affected by fumes of sulphuretted hydrogen, but they are deficient in body. The former is made by precipitating a boiling solution of sulphate of zinc, with one of chromate or bichromate of potassa; and the latter by substituting chloride of barium in the cold.

Chrome Red, or American Vermilion, is a beautiful scarlet pigment, made by the following recipe:

Melt saltpeter (nitrate of potash) in a crucible to dull redness, and add pure chrome yellow by small portions until no more red fumes arise. Allow the mixture to settle, then pour off the fused salt from the heavy residue. Wash the latter with water, which should be quickly poured off, and dry the pigment. The liquified salt poured off contains chromate of potash, and is reserved for making chrome yellow. When well made this is a beautiful pigment, but has all the faults of other preparations of lead.

Chrome Green—called also Oil Green, Green Cinnabar, Naples Green, etc. The chrome green of commerce is a mechanical mixture of chrome yellow and Prussian blue; the shades are made by varying the proportions. The true chrome green is the sesquioxide of chromium. Oxide of chromium, as an ordinary pigment, is deficient in brilliancy, but is considered permanent. It is chiefly used as a coloring on porcelain and fine pottery, it being one of the few colors which remain unchanged when submitted to great heat. It gives color to marbles, verd antique, serpentines, jasper, beryl, and other minerals, as mentioned before.

The following formula is given for the production of green cinnabar: Prussian blue is dissolved in oxalic acid, chromate of potassa is added, which is precipitated with solution of acetate of lead. The precipitate is thoroughly washed with water and dried. It is a beautiful green pigment; by varying the solutions different shades are obtained. The telegraph company of San Francisco use six ounces of bichromate of potash in each battery cup, and there are 3,000 or more in the City of San Francisco alone. The batteries are renewed every three months; all the solutions are thrown away and wasted. The chromic oxide could easily be recovered. Chromate and bichromate of potash are used as reagents in chemical analyses to detect the presence of lead, baryta, and mercury. These salts are also used in tanning leather.

DETERMINATION AND ASSAY OF ORES AND MINERALS CONTAINING CHROMIUM.

Chromic iron is valued for the percentage of the sesquioxide of chromium it contains. The assay is simple. Chromic iron is, however, extremely difficult to wholly decompose, which must be effected before a perfect assay or analysis can be made.

The following method is given by Fresenius: The ore must first be extremely finely divided by triturating in small portions in an agate mortar, or in a large way by bolting. For the assay, fuse eight parts, by weight, of borax in a platinum crucible; add to the mass while in fusion one part of the pulverized ore, and keep the crucible for half an hour at a bright-red heat; add dry carbonate of soda as long as it causes effervescence. Then gradually, and with frequent stirring with a platinum wire, add three parts of a mixture of equal parts of nitrate of potash and carbonate of soda, and keep the mass for a few minutes in fusion. When cold, dissolve in distilled water with heat, and filter. The residue which remains on the filter must wholly dissolve in hydrochloric acid, or the decomposition has not been successful, and the operation must be repeated with more care. The chromic acid, in the yellow aqueous solution, is thrown down by a solution of nitrate of mercury and the precipitated chromate of mercury, well washed and dried. When calcined, the volatile mercury is driven off, leaving pure sesquioxide of chromium, which is weighed and the percentage calculated. Sometimes the solution from the crucible is precipitated by acetate of lead, and the oxide of chromium calculated from the weight of the chromate of lead. It will be necessary in that case to nearly neutralize the solution with acetic acid before adding the acetate of lead. The calculation is made as follows: Suppose one gram of the ore was used in making the assay, and the sesquioxide of chromium obtained by the first method was 0.436. This multiplied by 100 would give the percentage=43.6. In the latter case it would be as follows, using the same figures: One part of neutral chromate of lead contains .3096 parts of chromic acid, and 43.6 of chromate of lead obtained would equal $43.6 \times .3096 = 13.498$, the percentage of chromic acid in the ore. To obtain the sesquioxide equivalent calculate as follows: One part of chromic acid contains .5200 of chromium, and one part of the sesquioxide .6842 parts of chromium, $\frac{6842}{5200} = 1.315+$. Then one part of chromium, obtained by the above calculation, would be equivalent to 1.3154 parts of the sesquioxide. To simply test for the presence of chromium in a mineral, the following will afford quick and reliable results: The ore is finely powdered in an agate mortar. A bead of borax is then formed in a loop, on the end of a platinum wire, by heating the loop by means of a blowpipe flame. While still red-hot, the end of the wire is touched to some powdered borax and again heated. This is repeated until a transparent bead of borax glass incases the loop. When cold, the bead should be colorless, if the wire was clean and the borax pure. The bead is then to be slightly wetted and touched to the powdered ore. Only a small portion should be allowed to attach itself to the bead. The blowpipe flame is again applied until the substance is perfectly fused with the borax. While hot, the bead will generally be of a faint yellowish color, but when cold, if chromium is present, it will become emerald green. If the bead is touched while hot with a piece of tin-foil, the reaction will be intensified. It sometimes happens that too much of the powder attaches itself to the bead and an opaque glass results. In this case the bead may be broken by a blow from a small hammer, and the powder placed on a piece of white paper, when the characteristic green color will be seen. This color must not be confounded with the bottle-green, which results from iron treated in the same manner.

To make this assay still more certain, proceed as follows: Saturate the borax bead as directed, using more of the mineral without regard to the color—dip the bead into pulverized nitrate of potash, and heat again strongly in the blowpipe flame. The bead will now be yellow and opaque. Repeat the operation as long as the flux can be made to remain on the platinum loop. Let it cool and detach by a blow from a small hammer. Grind the powder in an agate mortar with water until a solution is formed. Add a drop or two of acetate of lead, using a glass rod for this purpose. A yellow opaque precipitate will appear. Now transfer the liquid and precipitate to a small white paper filter, and dry. It will be easy now to recognize, under a microscope, chrome yellow on the paper. This is a very conclusive test, and can easily be made in twenty minutes.

LOCALITIES OF CHROME ORES.

Chrome iron is found in Russia, Norway, Shetland, France, Silesia, Bohemia, Styria, Asia Minor, Australia, New Zealand, New Caledonia, and in numerous localities in the United States other than California; but only in considerable quantities in the Bare Hills, near Baltimore. The wants of the world are estimated at 2,000 tons annually.

FOREIGN LOCALITIES.

J. Lawrence Smith visited Asia Minor in 1848 and discovered a deposit of chromic iron, fifty miles from the City of Broussa. He concluded that the serpentine contained the elements of the chromic iron, which may separate by force of aggregation from the rock mass. He found, also, magnesite, in which there were visible small specks of chrome iron.

Chrome iron is largely mined in Russia. The deposits lie in Perm, Orenbourg, and Oufa. The following table gives the production in "pouds," one poud equals thirty-six pounds, or nearly 526.64 ounces Troy.

PRODUCTION OF CHROME IRON IN RUSSIA.

[OFFICIAL REPORT.]

Year.	Number of Mines.	Quantity of Chrome Iron obtained, in "pouds."
1867	2	86.877
1868	5	41.084
1869	2	66.831
1870	9	600.024
1871	6	450.973
1872	7	372.549
1873	9	391.809
1874	6	316.561
1875	8	209.848
1876	4	58.167

At the chemical works in Russia, in which bichromate of potassa is prepared, the workmen are troubled with a disease peculiar to the business. The following description is taken from a technical paper:

The manager of the single establishment in Russia for the manufacture of chrome reports a curious disease among his men. He says: "The workmen suffer from the action upon the nose of the dust of bichromate of potash, and the disease manifests itself thus: A little hole is formed on the partition of the nose (dividing the two nostrils), and increases gradually until the partition entirely disappears, with the exception of the lower part of it, so that to a superficial observer there is nothing the matter with the nose except, perhaps, a little outward depression. It must be remarked that as soon as the partition is gone the process seems to stop there, and neither the lungs, air tubes, nor throat are in the least affected. Its influence is very different with different individuals. Some workmen, after having been employed for ten years at the works, remain unaffected; while with others the hole in the nose begins to be formed after one month's work. A general inspection of all the men at the works, not long ago, proved that more than fifty per cent of them had diseased noses. When the disease sets in first, the man feels tickling in the nose; a week or so after it bleeds, and in a few days more there is no uncomfortable feeling of any sort, and thus the hole is formed almost without any pain."

Dr. J. B. Trask, first State Geologist, was first to call attention to the deposits of chromic iron in California and their prospective value. In his report to the California Legislature, in 1853, he remarks upon the importance and the abundance of chromic iron in this State, specimens seen by him being declared equal to the best in the world. The principal localities known at that time were Nelson's Creek, at its junction with Feather River; between the North and Middle Fork of the American; on Bear River, four miles from Johnson's Ferry; in Coyote Diggings near Nevada; and on Deer Creek two miles from Nevada. Chromic iron is found in at least twenty-three counties in the State. Nearly all the localities are represented in the State Museum.

Alameda County, near the town of San Antonio. This locality has never been worked to any extent.

Amador County (1876), is from near Jackson; (2731), one mile south of Mountain Spring House.

Butte County (4678), Mount Hope district, near Forbestown.

Calaveras County (4470), near Murphy's, reported to be in considerable quantity. Campo Seco—a deposit of excellent quality, and said to be in quantity. This deposit can be worked to advantage when the narrow gauge S. F. & S. N. Railroad, is finished to Messenger's Valley, to which point it is nearly all graded. "In San Diego Gulch, on the east of the highest hill, opposite the Noble copper mine, is an isolated mass of chrome iron that will weigh thousands of tons."—[J. Ross Browne.] Specimens have been received, but not yet entered in the catalogue.

Del Norte County.—Chrome iron occurs north of the Low Divide copper mines, and at Smith's River, twenty miles from Crescent City. The ore is of good quality and has been quite extensively mined and shipped.

El Dorado County (960), ten miles west of Shingle Springs; (1402), exact locality not given; (2431), near Latrobe; ledge said to be from three to six feet thick.

Fresno County (1365), twenty miles from Fresno City, five specimens from as many districts, but all in the same neighborhood. A deposit of chromic iron was discovered in Fresno County in 1855, which was supposed to be silver ore. The excitement which followed led to the discovery of the New Idria quicksilver mine. The chrome ore lies in serpentine and exists in large quantities.

Lake County (4640), road from St. Helena to Knoxville, said to be in quantity.

Monterey County, near the San Benito River.

Napa County (797), near St. Helena.

Nevada County (5050), within two or three miles of Nevada City.

Placer County (3711), Michigan Bluffs; (3716), within one mile of Auburn; (5120), Section 21, Township 14 north, Range 9 east. At the Alabaster Cave there is an extensive deposit from which at least five hundred tons have been shipped. From the deposits in Placer County, located seven miles east of Iowa Hill (3711), shipments have been kept up quite steadily for the past year or two. This ore is of good quality and occurs imbedded in the country rock in disconnected bunches of irregular shape, and weighing from a few pounds up to several hundred tons each.

Sacramento County (1906), seven miles east of Folsom; (2768), near South Fork of the American River, nine miles from Folsom. Two thousand tons have been shipped from this locality. "Eight hundred tons of chrome iron now lying at Folsom. Two hundred tons shipped two weeks ago to San Francisco, to be sent as ballast to Baltimore. The ore comes from a distance of eight miles."—[S. W. Collins, May 18, 1880.]

San Francisco County.—Several unimportant deposits have been found on the peninsula of San Francisco. One on the ocean beach below the outlet of Lake Merced. No. (686) is from one of these localities.

San Luis Obispo County.—Chromic iron is particularly abundant in this county. The Flores vein, the leading mine in the San Luis Obispo group, has been explored by a tunnel two hundred feet long, which has opened up a fine body of good grade ore at a depth of nearly one hundred feet; (57) is from a deposit twelve miles from San Juan; (1578) is from the Pick and Shovel mine, six miles northeast from the City of San Luis Obispo. Up to July, 1880, four hundred tons of ore had been shipped; (2343) is from the London mine, four and a half miles northeast of the town. From the San Luis Obispo mines, located five miles southeast of the town, as much as five thousand tons per annum were taken for several years in succession. But little or nothing has, however, been done there of late, owing to the low prices ruling for chrome in the San Francisco market. Ezra Carpenter, in a letter of August 3, 1880, on file, gives the amount of chrome iron shipped from that port to date of letter, at 15,202 tons.

San Mateo County (2526), is from the Pacific slope of the redwoods. One sample selected assayed 50.12 per cent of chromic acid. The deposit is said to be large, but as yet no shipments of ore have been made.

Santa Clara County (394), is from a deposit five miles east of San José; (1154) is from Los Gatos.

Sierra County (4196), vicinity of the "Mountain House," near Downieville.

Siskiyou County (3601), high grade ore, half a mile from the town of Yreka.

Solano County (2772), found near the town of Fairfield.

Sonoma County (6), near Litton Springs; (174), four miles south of the town of Cloverdale. Mr. Edward Barnes mined and sold 2,000 tons from this deposit; 1,000 tons to Benjamin Flint; 500 tons to Cross & Co., and 500 tons to Kruse & Euler; cost to lay it down on wharf at Petaluma, $3 50 per ton, and at ships, $1 additional. Prices obtained as follows: To Kruse & Euler, and Benjaman Flint, $10 per ton; to Cross & Co., $7 50 per ton. The ore was found in bowlder form in serpentine. The original deposit was wholly exhausted, but Mr. Barnes thinks others might be found.

Tulare County (2493), was found ten miles from Portersville; quantity supposed to be considerable.

Tuolumne County.—The Engel mine is at York Tent, near Chinese Camp. The ore crops out boldly at several points, and at some of the croppings is four feet thick.

I am satisfied that the chrome ores of California are being sold too cheap. Of course, it is the policy of those who require these valuable ores to buy them at the lowest possible price, but it is not to the advantage of the State to deplete all the mines, and ship away the ores which should be saved for that time, not very far distant, when California will be a great manufacturing State. At the present ruinous prices, European consumers can afford to buy and store the ores, which the Californians are willing to dispose of at a trifle above cost of mining. The bane of the California miner and prospector is the desire to quickly realize on what he may discover. The rights of future generations, the requirements of manufactories yet to be established in the State, and the best interests of the State, are wholly ignored, in the selfish desire to get something for nothing, or to become rich without economy and labor. The same policy has caused enormous waste in the working of the rich ores of other metals in the State. The fact that half the mineral went to waste was no consideration, as long as the other half was made immediately available. There being little or no competition, those having ores to sell must take what is offered or allow them to remain in the mines, which, by far the best policy, does not meet the views of our miners. According to the recent report of Dr. James Hector, of the Geological Survey of New Zealand, chromic iron containing fifty per cent of chromic oxide is worth from eleven to twenty pounds sterling per ton ($53 to $97). This is from seven to twelve times the prices at which California chrome ores have been sold. Chrome iron imparts a green color to minerals and rocks with which it is associated. There is a variety of serpentine highly prized as an ornamental stone, known as "verd antique" (*vert antique*), oppiolite (*verde antico*) of the Italians and ancient Romans, which is a green serpentine, sometimes brecciated with strings of white steatite or noble serpentine veining it beautifully. It receives a high polish, but will not withstand the action of time. "*Verde di Prato*" is found in the Apennines, a few miles from Florence. It was largely used in the interior decoration of the Cathedral of Florence. "*Verde de Genova*" is found, as the name indicates, near Genoa. It contains veins of white and light green calc spar in green serpentine. These ornamental stones are again mentioned here in the hope that some prospector may search for and haply find a deposit of verd antique among the numerous localities of serpentine and chrome iron in California. The most of the chromic iron that has heretofore left the country has been sent, in the first instance, to San Francisco, and thence shipped around Cape Horn. More recently consignments are being made via the Isthmus, or overland by rail, small lots from the Placer County mines having gone forward during the past year by both of these routes.

PRODUCTION IN CALIFORNIA.

In attempts to gain information as to the quantity of ore raised in California, the State Mineralogist has met with so much opposition from those who are interested to conceal the amount, that no reliable data can be given. Steps will be taken in the future, that will probably result in obtaining the information, which will be given in reports to follow this. It may, however, be said, that the quantity is much larger than would generally be supposed by those who have given the matter no special attention.

CHROME SPINEL—See Picotite.

36. CHRYSOCOLLA. "*Gold Glue*" (Greek).

A green mineral passing to sky blue. H. 2—4, sp. gr. 2—2.24, luster vitreous to earthy, streak white. It is a hydrous silicate of copper ($CuO, SiO_2 + HO$) and when pure has the following composition:

Oxide of copper	45.3
Silica	34.2
Water	20.5
	100.0

It is more generally impure than the reverse, and often forms one of a group of copper minerals. B. B. decrepitates and colors the flame green, but does not melt. In a closed tube it gives water and turns black. With fluxes, yields a globule of copper. It is a rather abundant mineral in Southern California, being regarded in Owen's River Valley as an indication of silver mines. It is found as a stain on rocks in the vicinity of the croppings of silver and copper mines and with other minerals in the veins. No. (5926) is a fine specimen from the Copper World mine, San Bernardino County; (5158) is an association of chrysocolla, cerargyrite, and cuprite in beautiful microscropic crystals, from Lundy, Mono County; (1433) is from the Union mine, Inyo County; (2342) from forty miles south of Colton, San Bernardino County. It occurs also near San Carlos, Inyo County; at the Eclipse mine, same county; in the White Mountains, Mono County; in San Diego and San Luis Obispo Counties, and elsewhere in the State. It is a valuable ore of copper, for the reason that it can be easily reduced in the water jacket furnace to metallic copper.

37. CHRYSOTILE.

This is a magnesian mineral, a variety of serpentine, having no economic value. It occurs in veins or seams in serpentine, and is not uncommon in the State where the serpentines occur.

CINNABAR—See Quicksilver.

38. CLAY.

Clay may be defined as a hydrated silicate of alumina, contaminated, more or less, by various impurities mechanically intermixed with it. It is frequently colored by metallic oxides, and generally contains a small quantity of alkali. Clay is the product of decomposed crystalline rocks, brought down by the streams in former ages and deposited on the bottoms of lakes, seas, and other bodies of water. Glacial action has, no doubt, assisted the work of comminuting these rocks.

Pure clay when thoroughly incorporated with water becomes plastic, but when baked loses this property and becomes hard. As it shrinks in baking something has to be added to counteract this tendency. The nature of this addition differs with the requirements of the potter, and to determine what this should be often severely tests his skill. For making some varieties of porcelain a portion of infusorial earth is mixed with the clay. For making some other fine wares, quartz and feldspar are used, powdered brick, sand, etc., being employed for the coarser varieties. The addition of these foreign substances diminishes the plasticity of the clay and renders it more porous. Vessels intended to hold fluids, before being baked, are coated with a material that, fusing readily, acts as a flux, and glazing the surface fills up the pores. Unglazed pottery is called terra cotta. Porcelain is glazed by being dipped into a thin mud of finely powdered feldspar.

Besides the addition of these foreign substances all clays, except when used for the most common purposes, require to be subjected to a washing, sifting, and grinding process. They are also improved through exposure to the frosts and Winter rains, whereby a certain amount of decomposition takes place that relieves them of their impurities or renders the latter harmless.

OCCURRENCE IN CALIFORNIA.

The useful clays of every variety and degree of excellence are found at many places in this State. Of these, the following are the principal: At the town of Lincoln, on the Oregon Division of the Central Pacific Railroad, Placer County; at Michigan Bar and at Cook's Bar on the Cosumnes River, Sacramento County; near the Cities of San José and San Francisco, and at various places in Sonoma, Napa, Humboldt, Tehama, Contra Costa, Alameda, Calaveras, Inyo, Monterey, Los Angeles, and San Bernardino Counties. While the clay found at one locality, at least, is suitable for making the finest of earthenwares, a great deal of it answers well for making all the coarser varieties, as well, also, as vitrified ironstone pipe, fire-brick, crucibles, and other articles required to resist a high degree of heat. The Michigan Bar clay being well adapted for the manufacture of ironstone crockery, most of the potteries throughout the State obtain there the material for manufacturing this class of wares. The deposit in San Francisco, unless mixed with a better clay, is fit for making only the more cheap and common kinds of articles.

Elsewhere in this Country.—The occurrence of the useful clays is not confined to California. They are found in most of the other States of the Union, also in the Territories, being very abundant in the most of them. Coarse pottery of various kinds is made in New Mexico, Colorado, Utah, and Oregon; also fire-bricks—a great many of them in Colorado, Utah, and Montana. In several of the Eastern States, fire-bricks, tiles, stone-iron pipe, terra cotta, and the more common kinds of crockery are extensively manufactured; a very fair article of porcelain being also made in New Jersey and some other of the Atlantic States.

Kaolin.—During the year 1883 a deposit of this valuable clay was discovered near the town of Calico, in San Bernardino County. The finding of this mineral has frequently before been announced, but the material which gave rise to such announcements, on investigation, turned out to be something quite different, generally infusorial or diatomaceous earth, which, to the unassisted eye, has much the appearance of kaolin. Examined, however, under a microscope, the difference becomes clearly apparent, identifying this mineral without recourse to a chemical analysis.

Fire-bricks.—While we have in California clays of, perhaps, as good quality as are found elsewhere, we have not as yet done much towards supplying ourselves with fire-bricks, or other articles of a highly refractory kind. The principal reason for this has been the low prices at which the English bricks have sold in this market, being often brought as ballast on ships coming here to load with wheat. They are now selling in San Francisco at $30@$35 per 1,000, a price at which we can hardly afford to make and deliver them in the city, the principal distributing point on the coast. It may be, too, that our manufacturers have not always used as much care in making these articles as they should have done; nor, perhaps, has the clay employed been always of the best kind. We know, from many trials made, that we have good, if not the very best, of clays for this purpose; and if some of our home-made bricks have not given satisfaction, it may have been because good clays were not selected; or, more likely, because there was a lack of skill or care in making them. Deposits of first class fire clay are scarce even in England, and when found are considered very valuable. Neither in England nor France are the fire-bricks of uniform excellence, owing to difference in the quality of the clays from which they are made. The properties most desirable in a brick of this kind are ability to resist intense and long continued heat, sudden extremes of temperature, great pressure, and the action of corrosive substances; hence the value of a clay that fulfills, or comes nearest to fulfilling, these conditions. The term fire-proof clay is comparative, there being no clay that will resist the heat at which platinum melts. A brick may be said to be fire-proof that will answer the particular purpose for which it is required. All clays intended for the manufacture of fire-bricks should, however, be free from the oxide of iron, contain but little potash or soda, and be mixed with fifty to sixty per cent pulverized fire-brick, or baked clay.

The firm of Gladding, McBean & Company has placed in the State Museum samples of such of their clays as have been analyzed, both those used for the manufacture of fire-bricks and pottery wares, an example that should be followed by others in the business.

As the consumption on this coast is large and likely to increase, it may be expected that we will soon supply the demand, in good part, with fire-bricks of domestic make, fully half a million dollars having heretofore been paid out every year for English bricks and clay, some of the latter being also imported. An extensive bed of fire clay was discovered not long since in Inyo County, and having been tested in the cupola furnaces there, and found to stand well, this material will be likely to come into considerable use, as many structures of the kind will, in the course of time, be needed in that region, which abounds with rich galena and other ores requiring to be reduced by smelting.

OUR POTTERIES AND THEIR PRODUCTS.

Owing to the rather bulky and fragile character of this class of wares, works for manufacturing the coarser kinds of pottery were started in California at an early day. Although most of these pioneer establishments have gone out of existence, we have at the present time eleven potteries running in the State, besides several works at which drain and water pipes are made from cement. As yet not much, except the more cheap and common articles, have been produced here, such as vitrified iron-stone pipes, terra cotta, coarse earthenware, tiles, etc. Some little glazed yellow ware and other of the better grades of crockery have been made, and now that kaolin has been found in the State, it is probable something better than has yet been produced in this department will be attempted. The climate of California, by reason of our long dry Summers and even temperature, greatly favors the prosecution of this industry. Our imports in this line have been heavy, amounting to three thousand packages per annum—exports about half that number of packages, the most of them sent to Western Mexico, Central America, the Sandwich Islands, and British America. The largest establishment of this kind in the State is—

The Pottery of Gladding, McBean & Company, located at the town of Lincoln, Placer County, on the line of the Oregon Division of the Central Pacific Railroad. At this point the above company have put up capacious works, the main building being 160x230 feet, a portion of it three and the balance two stories high. Commenced in 1875, these works have since been from time to time enlarged, covering now two acres of inclosed floor-room. The machinery and apparatus here in use are of the most approved patterns, the whole being operated by a sixty-horse power engine. The deposit of clay at this point is of good quality, and very extensive, being between twenty and thirty feet thick and covering many acres. The articles made at this pottery consist of iron-stone crockery, and pipes for the conveyance of water, drainage, sewage, etc.; fire-bricks, architectural and ornamental terra cotta wares; fire, drainage, and sub-irrigation tiles; culvert pipes, well tubing, water filters and coolers; stove and flue lining, acid receivers, vases, flower pots, baskets, and boxes; water-closet bowls, slop-hoppers, grease traps, etc., the goods turned out here fairly representing those made at most of the other potteries in the State. This firm employs altogether about one hundred men. Their general depot and business office is at 1336 Market Street, City of San Francisco.

The Other Potteries in California consist of the following: The Pacific—proprietors, N. Clark & Sons—works, Sacramento; principal office and depot in San Francisco; employ eighty hands; obtain most of their clay from Michigan Bar, and manufacture nearly all the wares above enumerated. Andrew Steiger, at the City of San José, employs fifteen men, and makes a variety of articles, sewer pipe largely. Henry F. Bundock and George Maddox, having small potteries in Sacramento, employ from four to six hands each, and make not much except iron-stone crockery. The California Pottery and Terra Cotta Company, Miller & Windsor proprietors, have extensive and well equipped works at East Oakland; they employ forty-eight hands; obtain their clay from Michigan Bar, Sacramento County, and make ornamental terra cotta, vases, moldings, and trimmings for buildings, sewer pipes, etc.; office and depot in San Francisco, with a branch office in Oakland, and another in Portland, Oregon. Daniel Brannan works in Oakland, employs four to six men, and makes little besides flower pots and acid wares. Dennison & Son, Napa City, who employ from six to eight men, turn out only drain tiles. The Mission Pottery, located near the corner of Seventeenth and Harrison Streets, San Francisco, yard and office on Market Street, employs twenty hands, and manufactures iron-stone sewer pipe, coarse crockery, terra cotta ware, etc. This company have a small pottery at Michigan Bar, not running of late, though it is their purpose to start it up soon. They also own the deposit of clay at that place, which, being especially well suited for making stone crockery, is supplied to several of the other factories that make this class of ware. This material is also brought to San Francisco and mixed with the rather poor clays found in the vicinity of the city, so improving them that they can be used for making coarse articles to advantage.

A pottery of limited capacity was built not long since near Korbel's Mills, in Sonoma County, for making glazed earthenware from clay found in that neighborhood. A similar establishment was put up last year at Los Angeles, by Messrs. Hazzard & Earl; deposits of good clay occurring at a number of points not far from that city. The Albion Pottery, located at Antioch, and one of the earliest started in the State, has not been running for some years past, and will probably not again resume operations. It turned out at one time large quantities of fire-bricks, crucibles, stoneware, etc., made from clay found in a seam in the Black Diamond coal mine near by. One of the pioneer potteries of San Francisco, standing near the foot of Sixth Street, was some years ago converted into a sulphur refinery, for which purpose it has since been used.

CONDITION AND PROSPECTS OF THE INDUSTRY IN THIS STATE.

The potters about San Francisco, and elsewhere near the coast, keep up operations the year round. In the interior of the State, not much is done during the Winter, except at the larger establishments, where the processes are carried on mostly within doors. The capital invested in this line of business in California amounts to about three hundred and fifty thousand dollars; total number of hands employed, two hundred and seventy-five—one fourth of them, Chinese; most of the smaller works, however, employ only whites; wages paid vary from $1—paid the Chinese—to $2 50 per day; working by the piece, a common practice, skillful hands make from $3 50 to $4 per day.

The practice that has largely prevailed in this market of importing English crockery by the cargo, and selling it at auction, has forced our local manufacturers to so improve their wares, both as regards elegance of design and intrinsic merit, that they now compare favorably with foreign articles of the same grades; and it may safely be predicted that this branch of manufacture will so grow and improve as to greatly curtail, and perhaps wholly exclude, importations in the course of a few years. The demand for stone-iron pipe, for house and street sewerage, must necessarily increase rapidly, by reason of its great superiority for such purposes; while the requirements for flower pots, vases, and terra cotta wares, for the adornment of buildings, gardens, parks, pleasure grounds, etc., may be expected to keep pace with the increase of population and the growth of æsthetic culture among our people. Being so well provided with the raw material, it may be expected that works for manufacturing the higher grades of pottery, including, perhaps, porcelain wares, will very soon be established in California. We have here not only the clays, but also all the other ingredients required for making both the common and the finer kinds of pottery; quartz for supplying the silica, feldspar, lead, borax, and soda, being abundant in this State.

THE BUSINESS ELSEWHERE IN THE UNITED STATES.

There is a pottery in Oregon, also one in Utah, and several in Colorado, the number of these works in the United States amounting, according to the census report of 1880, to 686; the whole giving employment to 8,494 hands, using up $2,564,359 worth of raw material, and turning out manufactured products to the value of $7,942,729 annually; capital invested, $6,380,610; expended in payment of wages, $3,279,535 per year. In the same year there were in this country 5,631 establishments devoted to the manufacture of brick, tile, drain pipe, etc.; they had an invested capital of $27,673,616, employed 66,355 hands, paid $13,443,532 in wages, used up $9,774,834 worth of material, including fuel, made 3,822,362,000 common brick, 163,184,000 firebrick, 210,815,000 pressed brick, $2,944,239 worth of tile, $1,765,428 worth of drain pipe, $719,926 worth of all other articles, and had a total value of all products of $32,833,587.

HISTORY AND PROGRESS OF THE CERAMIC ART.

The art of molding the plastic clays into useful and elegant forms is one of great antiquity, having been practiced by the more enlightened nations from the earliest periods of which we have any record, and even perhaps by those of prehistoric times. Indeed, there is reason to suppose that in the broken pottery, inscribed bricks and other ceramic relics, dug up in various parts of the world of late years, we have all that remains of races who once existed, but of whose presence on this planet every trace, save only these simple impressions in clay, has been extinguished. Scattered over the valleys and mesas of northwestern Mexico and of Arizona are to be seen fragments of pottery made probably by a people of whom there is left not even so much as a tradition, they having disappeared before the Toltecs, their successors, came to occupy those regions. Babylon and Nineveh are gone—so nearly obliterated that it is difficult now to identify the sites they occupied; but the Assyrian tablets and the cunieform inscriptions remain to attest the existence of these once mighty cities. Burned into the indestructible clay, more enduring than granite or marble, these simple characters survive to tell in disjointed sentences the story of the past. The initials C. H. impressed in the brick of which our new City Hall is built, put there to denote that they were intended for that edifice, may (should they prove to possess the lasting properties claimed for them) become to the antiquary of the remote future a source of much worriment as he labors to decipher their probable meaning.

THE ART IN MODERN TIMES.

Though so generally practical and held in such high esteem by the ancients, the ceramic art has been hardly less appreciated in later years, the demand for its products having kept pace with the progress of æsthetics and the culture of public taste. Requirements in this line of production, both for purposes of utility and ornamentation, are growing rapidly, as is shown by the number of men engaged in the business, and the extent to which articles of this kind are being introduced in building, as well as for embellishing grounds, etc.

So far as the making the very finest grades of pottery are concerned, the Chinese and Japanese have in recent times divided the art between them, for which reason the name "China" has been given to this class of wares; the term "porcelain," by which also they are known, being derived from *cyprea porcellana*, which shell they resemble. For a long time the Europeans obtained these fine wares exclusively from the Orient, but finding at length excellent clays at home their own artisans began to imitate them very closely. In the year 1710, Frederick Bottcher having put up rude works at Meissen in Saxony, succeeded in making pottery much resembling the Chinese article, and a deposit of kaolin having afterwards been found near by, such importance was attached to it, that its exportation was prohibited under the severest penalties.

In 1765, the extensive deposit of fine clay at Sevres, France, having been discovered, works were put up there, at which, under the supervision of the Government, there have continued to be manufactured large quantities of porcelain ware ever since. In connection with these works a ceramic museum has been established at that place.

The clay deposits of New Jersey, in connection with the potteries erected for utilizing this material, are of great economic value to that State, these works giving employment to a large number of men, while their products find market in all parts of the Union; and yet, as before remarked, there is little doubt but equally good clays exist in various other parts of the country, it having been proved that we have such deposits in California, though their extent has not yet been fully established.

BRICKS.

Owing to the destructive fires that were of such frequent occurrence in the towns of California during the early history of the State, bricks coming into large demand for building purposes, the business of making them was extensively engaged in, brickyards having been started all over the State. Of late years we have manufactured these articles at the rate of perhaps 250,000,000 per year, more than one half being used in and about the city of San Francisco, in the vicinity of which a large proportion of them are made, notwithstanding little really good clay is found there. Since the more compact portions of the larger towns were built up we have consumed comparatively few bricks, most buildings put up in the country and outside the fire limits in the cities being constructed of wood. The adobe, a large sun-dried brick, was, in early times, the only material used for the walls of dwellings, and in fact for structures of every kind, the corrals, churches, presidios, everything, being composed of this cheap unburnt brick, which, when protected from the rains, stands for a long time. In sections of the country largely inhabited by Mexicans, native Californians, or other races of Spanish descent, as well, also, as in localities where lumber is scarce, the adobe is still much employed in the erection of dwellings, corrals, etc.

Nearly all our large factories, foundries, woolen mills, churches, suburban residences, and country villas, and, in some instances, even our educational institutions, are built of wood. We have, however, a good many structures in which a large number of bricks have been used. Into the Palace Hotel, San Francisco, 23,000,000 bricks have been laid, nearly as many having been disposed of in the construction of Fort Point. One reason that lumber has been so generally employed here in building is its greater cheapness and convenience as compared with bricks. Then the kind mostly used for this purpose, the redwood, is easily worked, never warps, and is very durable, lasting, even when exposed to the weather, for a very long time. Sticks of this timber in the old Mission churches of California remain as sound as when put in place a hundred years ago.

In selecting a site for his business the California brick-maker has been embarrassed by the twofold trouble of securing cheap transportation to market and a sufficiency of clay suitable for his purpose, the latter not always an easy thing to do in California. Sometimes our clays show an excess or deficiency of sand, while again they are contaminated with alkali, magnesia, or other objectionable mineral. As much of our clay is of an inferior quality so are the beds apt to be superficial, few of them anywhere having a depth of more than fifteen or twenty feet, those about San Francisco being even more shallow.

A great many bricks are made near the cities of San José, Stockton, and Sacramento, at all of which a tolerably good clay is found. The pressed bricks made at San José are said to be nearly equal to the Philadelphia article, than which there are probably no better made anywhere. As many as six or seven million bricks per year have been turned out at the San Quentin State Prison, all marketed in San Francisco.

In the manufacture of bricks two methods are employed in this State, the old one of burning in kilns and a new method known as the Hoffman process, by which they are baked in furnaces, some of which are capable of holding nearly half a million at a batch. The advantages of this system consist in a saving of time, a batch being burned in about a day and a half, and in the ability to continue operations during the Winter, when by the old plan they have to be suspended, the working season in that case extending only from April to November. The price of bricks in San Francisco varies from $9 to $10 per 1,000 for ordinary, and from $25 to $30 per 1,000 for pressed. This business, in which there is hardly less than $1,000,000 invested, gives employment, directly and indirectly, to about 1,700 men during the six dry months of the year, and to about one third that number during the wet season, a third of the whole being Chinamen.

Burners in this business receive $70 per month; molders and setters $45, and ordinary hands $35 to $40 per month, board in all cases being included—Chinese, less these rates by thirty-five per cent.

CEMENT PIPE—ITS MANUFACTURE AND USE.

We have in California a number of establishments for the manufacture of this class of products, of which some mention may here properly be made. Not much pipe of this kind has been made in the city of late, its use having in great measure been prohibited by the municipal authorities. Very extensive works for its manufacture have, however, been put up at Ontario, in San Bernardino County, where great quantities are being turned out for use in that neighborhood. This pipe is employed mainly for the drainage of grounds and the conveyance of water, for which purposes it answers extremely well. As a water conduit it is especially valuable, being cheap, healthful, and capable of withstanding considerable pressure. A great deal of it will hereafter be required in California, as we will have much land to drain; then, water running in flumes or open ditches undergoes such waste in this hot and arid climate, that it will be found economical to carry it largely in pipes, whereby it will be protected from evaporation and absorption. The extent to which irrigation must come to be practiced in this country, makes our prospective wants, in this direction, very large. Vitrified clay sewer pipe is made by machinery, the clay being forced by a plunger through a cylinder, in which there has been placed a core, the sections or joints, cut off in three-foot lengths, being set on end in a well aired room to dry. The socket for the joint is pressed in a plaster mold, and poured in while the clay is damp. When perfectly dry, the joints are dipped into a vat containing water, holding a substance known as Albany slip in solution. After being again dried, they are hard burned.

COAL—see Mineral Coal.

COBALT—see Erythrite and Millerite.

COBALT BLOOM—see Erythrite.

39. COCCINITE. Iodide of Mercury.

Locality given by Dana, San Emidio Cañon, Kern County.

COLEMANITE—see Priceite.

40. COPPER. Etym. *Cuprum* (Lat.).

Copper has a wide distribution in nature, being found in most parts of the world. It is one of the few metals that occurs in the metallic state in nature, for which reason it was in use by primitive man long before he learned to extract it from its ores. It also possesses properties that impart to it a special value. It is malleable alone, but may be hardened by alloying with other metals, as with tin, producing bronze, and with zinc, producing brass. It fuses readily, and when polished is a beautiful metal, possessing a rich color and considerable luster. Copper was an article of commerce in America in the time of the mound builders, and perhaps earlier, as the mines of metallic copper, on the shores of Lake Superior, appear to have been extensively worked by a people concerning whom there exists now no tradition or record. In the days of the alchymists copper was named from Venus, and given the same astronomical sign. In later times this metal has become indispensable, and it is fortunate that its distribution is so general over the surface of the earth. While some of its ores have been found very rich, the greater portion of the world's product has been obtained from those of low grade. This has heretofore not been generally understood, especially in California, where, not until recently, have any attempts been made to utilize the poorer varieties of ore.

PRODUCTIVE LOCALITIES IN THIS STATE—THE COPPEROPOLIS MINES.

While it is well known that copper ore occurs at a great many places in California, we are still much in the dark as to the extent and value of our cupriferous deposits, so little have they as yet been exploited. Dr. John B. Trask, first State Geologist, reported finding the ores of this metal in almost every county in California. Although this was the first officially recorded discovery of copper in the State, its existence here had been well known long before. The localities at which more or less work has been performed, and considerable quantities of ore have been extracted, are the following, there being many others where the occurrence of the ore has been observed and some exploratory work done: At Copperopolis, Calaveras County, where a large body of good ore was discovered in the Union mine in the Summer of 1861. Afterwards this deposit was extensively exploited, over 60,000 tons of ore having been extracted from it during the next six years, when, by reason of diminished ore supply, litigation, and lower prices for copper, work on this and adjacent mines was suspended, and has never since been resumed. From the Empire, Keystone, and various other claims in the vicinity of the Union, several thousand tons of copper ore were taken during the above period, nearly all of which was shipped to Liverpool, at a cost (freights and other charges included) of about $25 per ton, this being aside from cost of mining, sacks, etc. Owing to these heavy expenses, no ore carrying less than 10 per cent metal was ever shipped from these mines, the Union ore sent away having averaged about 15, and that from the other mines about 16 per cent. At the time operations were suspended on the Union mine the lode had been opened up to a perpendicular depth of 500 feet, at which point it showed a width of 15 feet, and still carried a good body of medium grade ore. The depth reached on some of the other mines on the range was nearly as great, the show for ore on these being also tolerably good when work was closed down in 1867.

This Copperopolis find led to much prospecting for and the discovery of numerous other deposits of copper ore in California, a good deal of money having been expended in the search, and afterwards in opening up mines and supplying them with plant, between the years 1861 and 1868.

THE CAMPO SECO MINE.

During the period above mentioned a deposit of copper ore was discovered one and a half miles from the town of Campo Seco, Calaveras County, in a heavy cupriferous belt that here traverses the country. Furnaces were put up here at an early day, and a railroad built connecting them with the mine, which, at the time of my visit, I found had been opened by a vertical shaft 275 feet deep, and by three levels, 80, 140, and 200 feet deep respectively. From Mr. C. Berger, Superintendent, I learned that the vein is well defined in a country of slate; course of vein, northeast and southwest; dip, 62° S. E. In his opinion there is here a large body of ore that will average ten per cent copper. The hoisting-works are driven by water communicated by an ordinary hurdy wheel at a cost for water of three dollars per day. The ores are generally chalcopyrite with some bornite and iron pyrites. The reduction works put up here are extensive and complete. The ores after being passed through a rock-breaker are dry-crushed by a Dodge pulverizer, and passed through a 40-mesh screen at the rate of twenty-five tons per day. Falling into a chamber, the dry pulp is carried from this to a more elevated chamber, and thence fed into a Dodge rotary roaster, lined with fire-bricks. As this furnace, which is forty feet long and octagonal in form, slowly revolves, the ore falls from each interior face in a succession of drops, while the reverberatory flame passes through from end to end; the ore at the same time moves slowly forward and finally drops into a receiving chamber of brick. The roasting is so managed that the sulphur in the ore is oxidized to form sulphate of copper. The operation is checked from time to time by withdrawing a portion of ore, and shaking it up in a test tube with water and ammonia, when it yields a blue solution, which is compared with similar solutions of known strength. This, added to preliminary assays of the raw ore, gives data by which the roasting may be regulated. The roasted ore is withdrawn from time to time from the receiving chamber, and extracted with water in large brick vats set at a slightly lower level The solution containing sulphate of copper is drawn into similar vats at a still lower level, into which scrap iron has been placed. In these vats sulphuric acid leaves the copper and takes an equivalent of iron, for which it has a greater affinity, forming basic sulphate of iron, which is drawn off and allowed to go to waste, although its value is well known. The cement copper is then detached from the iron scraps, dried, placed in bags, and sent to San Francisco, and a market. After a brief trial of the above method these works were shut down, and have since so remained, but whether in consequence of defects in the process employed, or the low price of cement, we are not advised. Cement copper, which a few years ago commanded eighteen cents per pound for eighty-five per cent, can now be sold for only twelve cents for one hundred per cent, or at that rate.

Commencing in 1869 and continuing until 1873, Mr. E. T. Stein treated the low grade ores from the Napoleon mine by the Haskell patent process, whereby the liquors from which the copper has been precipitated are required to be returned to the heaps for a second operation. Except in this particular, the Haskell process differs not materially from that above described. Mr. Stein made twelve tons of good quality Venetian red from his waste solutions, and found the business, while engaged in it, fairly profitable.

THE SATELLITE MINE AND WORKS.

This mine, now owned by Horace D. Ranlett, of San Francisco, is the old Lancha Plana under a new name. It is situated one and a quarter miles from the town of Campo Seco, and lies on the southeast quarter of Section 4, Township 4 north, Range 10 east, Mount Diablo meridian, and appears to be on the same belt with the Campo Seco mine, both having been discovered in 1861. Extensive reduction works, including a smelter, were put up here in 1865-6, at which time as many as one hundred and fifty men were employed about the mines and works. The ground is opened by two shafts, three hundred feet apart; the one represented to be three hundred and the other four hundred feet deep—the two being connected by a level. There were formerly extracted from this mine large quantities of rather low grade pyritic ores, which are now being leached. From the bottom of a winze put down from a new level, over a ton of metallic copper, consisting of magnificent specimens, has been extracted, also masses of ore largely melaconite, and containing granules of native copper. These ores occur in a shistose rock having a nearly vertical dip, and which is capped by a heavy deposit of gravel, formerly worked for gold, and not yet exhausted. Latterly, some two thousand tons, composed mostly of oxidized ores, have been raised here, about one fourth of which was shipped to Baltimore and the remainder placed on the heaps now being leached. The copper-bearing minerals observed here consist of chalcopyrite, bornite, melanconite, azurite, and chalcanthite, with quartz, barite, slate, serpentine, and a rock resembling diorite. Although generally of low grade some of the ore found in this mine is extremely rich, the stock appearing to be ample to keep the reduction works employed for a considerable time.

These works, erected at a cost of $2,500, differ but little from those of the Sunrise Company, the roasting being conducted on the same principle. Scrap iron delivered at the mine costs from $10 to $20 per ton in carloads, freight being from $3 to $4 per ton. Burson, the new station on the San Joaquin and Sierra Nevada Railroad, is about four miles from the mine, the latter being twenty-three miles easterly from the town of Lodi on the Central Pacific Railroad. Water can be procured from the Mokelumne and Campo Seco Canal and Mining Company by laying a pipe one thousand feet in length, whereby a fall of one hundred and seventy-five feet can be obtained, affording a fifty-horse power at an estimated cost of $8 per day. The copper cement produced at this mine is sent principally to Boston, Baltimore, and New York, with a little also to Liverpool.

The Little Satellite, an extension of the Satellite, and formerly called the Star, is also owned by Mr. Ranlett. It lies parallel to the Campo Seco mine, and shows good indications of ore, having recently been opened by a tunnel. From the old Star shaft considerable ore was extracted at a depth of ninety feet.

SUNRISE MINES AND WORKS.

Situated on the banks of the Mokelumne River, two miles from Campo Seco, are the Sunrise Placer Mining and Copper Reduction Works. The material operated upon here consists of the low grade ore taken from the old dumps of the Campo Seco copper mine, the business being conducted on an extensive scale, and, it appears, with very satisfactory results. Two methods of treatment are employed here. By one of these the ores are roasted, and by the other not. By the former, the higher sulphuretted ores are piled up in heaps, on a foundation of rough stones. Along this foundation work, at intervals of ten to fifteen feet, arches are formed, connected with vents in the chimney. The ore having been piled on these arches, the firing is commenced in them by burning wood; when sufficient heat has been produced to start the burning of the sulphur, the whole pile is covered with earth, and the air excluded, except small quantities entering the orifices at the several fire places. The sulphur continues slowly burning for from five to seven months. White fumes of sulphurous acid escape from the chimney, forming beautiful crystals of sulphur about the vents. The operation is ended when no more fumes are seen to escape, after which all the vents are closed and the pile allowed to cool. The roasted ore is then treated like the raw ores by the second process.

The raw ores containing much sulphuret of iron are placed on beds of rough and rather large stones, the beds being horizontal and loosely piled. The foundation upon which the rough stones are placed is slightly inclined towards the collection and precipitating tanks on the river bank, and is made water-tight with cement. The water supply is obtained from a reservoir fed from a mining ditch near by, this reservoir being connected with the ore beds by small iron pipes. To the ends of these pipes flexible hose are attached, ending in sprinklers, which throw a gentle spray over the piles of pyrites. The water sinks through the loose ore and assists in oxidizing the iron and copper pyrites to sulphates, which are dissolved by the percolating stream that flows into a collecting cistern, whence they are conducted to a series of sluices placed nearly level and in which large quantities of scrap iron have been thrown. The copper is precipitated but the sulphate of iron remains in solution and is allowed to go to waste. When the copper has accumulated in sufficient quantities the iron scraps are washed in a tank, whereby the copper is removed from the larger pieces, which are returned to the sluices for a fresh operation. To remove the smaller pieces of iron which result from the rapid solution of that metal, the cement copper is washed in a cradle on a punched screen through which the pulpy copper passes while the metallic iron remains behind. The cement is then dried artificially and packed in bags for shipment. The operation is simple and requires but few workmen, while the yield is very satisfactory. Messrs. F. W. and C. S. Utter, proprietors of these works, are also treating in a similar manner the ores from the old Napoleon and Empire mines near Quail Hill, Calaveras County. Mr. C. S. Utter, the superintendent, estimates the production of cement copper per annum at 9 tons to each man employed. The yield of the Sunrise works is about 40 tons per year. In the above described process the sulphur and the iron are wasted, both of which should be saved. In roasting the crude ores the sulphur could be saved as sulphur or made into sulphuric acid. The large quantity of metallic iron scraps used for reducing the copper is changed in the process into basic sulphate of iron, also allowed to go to waste. The solutions containing it should, however, be run off into shallow tanks and evaporated to dryness by the heat of the sun. This dry residue sent to San Francisco could be converted into Venetian red by simple calcination, or be treated with sulphuric acid and crystallized into green vitriol or sulphate of iron, which is the best of all disinfectants for sewers and closets, and has uses in many of the arts. It is to be hoped that this valuable product will hereafter be saved and turned to profitable account.

THE SPENCEVILLE MINES AND REDUCTION WORKS.

These mines, owned and operated by the San Francisco Copper Mining Company, are situated at the town of Spenceville, Nevada County, twenty miles east from Marysville, and at an elevation of 400 feet above sea level. The company's claim, consisting of 3,000 feet, forms part of the broad copper-bearing zone that crosses this region in a northerly and southerly direction, and which, during the era of copper excitement, already alluded to, was the site of great activity, thousands of claims having been taken up and much work done upon them. As the excitement died out, these claims were gradually abandoned. After a time, Mr. C. Berger began experimenting on these ores, and becoming satisfied that they could be made to pay under proper treatment, the above company was formed and commenced operations, the method of reduction in use here differing but little from that employed at Campo Seco. The works of this company are very extensive, as are also the developments made on the lode, which is worked after the manner of an open quarry. The excavation opened covers nearly an acre, and has been worked to a depth of about 100 feet. The ore is brought out on cars running on an incline. The hoisting works, mill, roasting sheds, leaching vats, etc., cover several acres, the improvements made by the company having cost over $100,000. They employ a working force of seventy-five men in and about the mines, besides wood-choppers, teamsters, etc., and turn out monthly about forty-five tons of copper cement, averaging eighty-five per cent metal. They keep a large supply of ore constantly on hand, there being, it is said, heavy reserves exposed in their mine, which will assay from three to five per cent copper; the ore worked averaging four per cent copper. The operations of this company are and for several years past have been paying a fair per cent on their investment.

The Newton mine, in Amador County, continues to turn out copper cement in limited quantities, and with some profit; there being several other mines, in different parts of the State, that are extracting ore in small lots, the most of which are sent to the San Francisco market.

The following are given, with authorities, as some of the localities in which copper occurs in California:

Cow Creek, Shasta County (1751); with Azurite, Telegraph mine, Hog Hill, Calaveras County (2401); Iron Mountain, Shasta County; Union mine, Calaveras County; Dendritic or Mess Copper (Blake); Keystone mine, Calaveras County (Blake); Napoleon and Lancha Plana mines, Calaveras County, and Cosumnes mine, Sacramento County (Blake); Santa Barbara County, disseminated in grains in serpentine rocks (Blake). It occurs with Rhodonite at Mumford's Hill, Plumas County (Edman).

PRODUCTION MADE ON THE PACIFIC COAST.

The metallic copper or its equivalent in ores produced on this coast may be set down for the year 1883 as follows: California, 700 tons; Nevada, 500 tons; Arizona, 10,000 tons; Montana, 8,800 tons; a total of 20,000 tons; this industry in the above Territories being now in a very flourishing condition. During the year 1882, there were shipped from San Francisco to England by sea 864,700 pounds of copper ore, and by rail east 126,541 pounds of copper, 1,795,104 pounds of copper cement, and 100,000 pounds of copper ore; the shipments of these several products for the past year having been a little larger.

FOREIGN PRODUCT.

We copy from the New York Engineering and Mining Journal the following table, compiled by Messrs. Harry R. Merton & Co., of London, showing the production of copper made in the countries mentioned during the past five years; the figures marked with a star being estimates:

	1883. Tons.	1882. Tons.	1881. Tons.	1880. Tons.	1879. Tons.
Algiers	*600	*600	*600	*500	*500
Argentine Republic	293	800	307	*300	*300
Australia	*12,000	*8,950	10,000	9,700	9,500
Austria	*500	*455	455	470	245
Bolivia—					
Corocoro	*3,250	3,259	2,655	*2,000	*2,000
Chili	41,099	42,909	37,989	42,916	49,318
Cape of Good Hope—					
Cape Copper Company	5,000	5,000	5,087	5,038	4,328
Canada	329	221	50	*50	*50
England	*3,000	3,464	3,875	3,662	3,462
Germany—					
Mansfeld	12,643	11,516	10,999	9,800	8,400
Other German	*1,220	*1,743	1,743	1,000	*600
Hungary	*1,000	*976	976	976	976
Italy	*1,600	*1,400	*1,480	*1,380	*1,140
Japan	*2,800	*2,800	*1,900	*1,900	*1,900
Mexico	489	401	333	*400	*400
Newfoundland—					
Betts Cove	1,053	1,500	1,718	*1,500	*1,500
Norway—					
Vigsnaes	2,340	2,300	2,350	2,040	2,000
Other Norwegian	*290	*290	290	386	412
Peru	395	440	615	*600	*600
Russia	*3,000	*3,000	*3,000	*3,081	3,081
Sweden	800	798	995	1,074	800
Spain and Portugal—					
Rio Tinto	20,472	17,389	16,666	16,215	13,751
Tharsis	*9,800	*9,000	*10,203	*9,151	*11,324
Mason & Barry	*8,000	*8,000	*8,170	6,603	4,692
Sevilla	2,026	1,885	1,340	1,705	1,360
Portugueza	2,357	1,700	1,410	1,000	770
Poderosa	*1,000	*800	*800	*800	*800
United States	52,080	39,300	30,882	25,010	23,350
Venezuela—					
New Quebrada	4,018	3,700	2,823	1,800	1,597
Totals	193,454	174,596	159,711	151,057	149,156

What promises partial relief from the disadvantage of costly transportation alluded to, is the practice now coming into vogue of concentrating the low grade copper ores, or reducing them to regulus at the mines, a plan that in this State is likely to be widely acted upon hereafter. It is probable, too, that we shall yet see a comprehensive system of reduction works established at some point on the Bay of San Francisco, whereat every class of copper ore can be economically and successfully treated, and a regular market be thus furnished for the product of our mines. The method here so often pursued of erecting small and imperfect works on the ground for handling only the richer portion of the ores is both expensive and wasteful. The secret of the success reached at Swansea, Wales, in treating copper ores, consists in securing great quantities of every class of ores, and through skillful selection so combining them that one class supplies the elements in which another is deficient. We have only to adopt and carefully carry out the methods practiced in these older countries to render copper mining a very prosperous industry in California.

THE PROBABLE FUTURE OF THE BUSINESS IN THIS STATE.

With some improvement made in the methods of reduction, transportation somewhat cheapened, and conditions otherwise more favorable now than aforetime, an increased output of copper ores may be looked for in California, our cupriferous resources being undoubtedly very considerable. Some of the richest deposits yet found in the State have remained unworked and but little developed, partly because mining for the precious metals has been with us the all-absorbing pursuit, and partly owing to the cost of transporting this class of ores to market, the Rodger's mine, in Hope Valley, lying in the eastern part of Amador County, being a case in point. The ore here, a combination of sulphide, oxides, and carbonates, is very rich, and so attractive in appearance that it has been much sought after for cabinet specimens. Though discovered nearly thirty years ago the deposit has not yet been sufficiently exploited to determine its extent or value. So, also, the deposits in the Alta district, Del Norte County, though discovered many years ago and known to abound with ores of good grade have been almost wholly neglected; the fifteen miles of wagon transportation, over a rough country to Crescent City, having been the barrier to their earlier development.

TESTING AND ASSAYING COPPER ORES.

Copper ores are tested and assayed by the following methods: To simply ascertain if an ore, mineral, or substance contains copper, the simplest method is to place a small fragment on a clean piece of charcoal, and heat it strongly before the flame of a lamp urged by a blast from a common mouth blowpipe. This may be continued for some minutes. Then a few drops of hydrochloric acid is taken on a glass rod and placed on the assay. This may be repeated several times until the fragment of ore is wet with the acid. A fine pointed blowpipe flame is then directed on the assay, and if the flame is turned distinctly blue, copper is present. This experiment is best made in the dark. The ores of copper when pulverized and heated before the blowpipe with fluxes (carbonate of soda and borax) yield generally a globule of copper, which may be recognized as such by being hammered out thin and scraped with the point of a knife. If now examined by daylight under a microscope of moderate power there can be no mistake, especially after some experience obtained by practice.

To make an *assay* of ore for the copper it contains, a different treatment must be employed. The ore is first to be finely pulverized and sifted. A portion is then weighed out with accuracy—say five grams. This is placed in a clean small porcelain evaporating dish, and wet with concentrated sulphuric acid, after which it must be stirred with a glass rod, or strip of glass, which must not be removed during the operation. The dish is then set either out of doors or under a chimney having a strong draft, when a few drops of nitric acid is poured upon it. Intense action generally takes place with the evolution of orange fumes of nitrous acid, the inhaling of which should be carefully avoided. When the action partially ceases more acid is added at intervals, until a green liquid is obtained, containing copper in solution. During this operation the mixture should be frequently stirred with the glass rod. Gentle heat is then applied, with frequent stirring on a sand bath, until the contents of the dish are reduced nearly to a state of dryness, great care being taken to prevent loss by spurting. After the mass has been allowed to cool, sulphuric acid and water are added, and the whole poured on a paper filter. Carefully washing the rod and dish with water, this is also poured on the filter. The contents of the latter are washed with water, until the dropping filtrate has no taste. When the operation is finished the clear green liquid is poured into a capacious and clean beaker glass, and gently heated. A strip of clean Russian sheet iron is prepared and placed in the beaker. It should be at least two inches wide, and long enough to project above the liquid, so that it may be handled. In a short time all the copper will be precipitated, which is shown when no more falls, when the adhering copper is shaken from the iron slip. The iron is then removed, and the liquid decanted from the precipitated copper, leaving enough to cover the precipitate. Boiling water is then poured on, and in a few minutes decanted. This is repeated several times. The last time the whole is poured on a weighed filter, and washed several times with boiling water, then with alcohol, and lastly with ether. The filter is then removed from the tunnel, and quickly dried on a water bath and weighed. When the weight of the filter is deducted, and the remainder multiplied by twenty, the result will be the percentage of copper in the ore. This assay is very accurate, if carefully performed, but unreliable otherwise. The assay by the volumetric method and by fire may be learned from chemical text-books and works on assaying; but the above will answer the purposes of the prospector sufficiently well.

SULPHATE OF COPPER.

Crystallized sulphate of copper has the following composition:

Oxide of copper	31.86=copper, 25.3 per cent.
Sulphuric acid	32.07
Water	36.07
	100.00

The crystals should be blue, without any green shade. They crystallize in the rhomboidal system. Sulphate of copper dissolves in 4 parts of cold, or 2 parts of boiling water. The following table will show the amount, in per cents, that a solution of sulphate of copper contains of the crystals at 75° F. It must be assumed that nothing is held in solution but sulphate of copper:

At 10° Beaumé	7 per cent.
At 12° Beaumé	8 per cent.
At 15° Beaumé	10 per cent.
At 18° Beaumé	12 per cent.
At 21° Beaumé	15 per cent.
At 24° Beaumé	17 per cent.
At 27° Beaumé	19 per cent.
At 30° Beaumé	20 per cent.

The usual impurity of sulphate of copper is sulphate of iron, with which it forms a double salt that cannot be separated by crystallization. This may be detected by adding to a solution of the crystals, first, a drop of pure nitric acid, and then sufficient ammonia to form a clear deep blue solution; if the sulphate of copper is pure, there will be no residue of floating particles. If these are seen, of a flaky brown appearance, it is a proof that the sulphate is impure and contains iron. The quantity will give an idea as to the extent of this impurity. This iron can be removed and pure sulphate of copper obtained. This is effected by heating the crystals to dull redness and redissolving, which leaves the sulphate of copper nearly pure; as this is a costly operation it is seldom resorted to unless the copper is very impure. Commercial sulphate is supposed to contain some sulphate of iron.

Sulphate of copper is made on a large scale in several different ways.

If the ore is a sulphide, which may be known by roasting a powdered sample in a shovel, when the smell of burnt sulphur may with certainty be recognized, the ore must be roasted.

If no sulphuric acid is to be used the roasting must be done in a reverberatory furnace, with free access of air, and the roasting *must not be pushed too far.* The exact point can only be learned by practice; it will be found to require considerable skill. When the exact point is reached the ore is drawn out and spread on an inclined surface, and sprinkled with water. The incline is so arranged that the water may be collected and again returned to the roasted ore. After a time the wash water becomes blue, and may be evaporated to crystallization. Sulphate of copper so obtained generally contains much sulphate of iron, which must be separated as before described.

If it is intended to use sulphur the roasting must be pushed further. The roasted ore is then boiled in sulphuric acid and water, and the solution evaporated to 30° Beaumé, and left to crystallize. This is best done in copper pans, but may be done in lead-lined tanks.

Some ores, such as oxides or carbonates, may be decomposed economically by boiling in sulphur without roasting. The following experiment will determine if the ore is of such a nature. Boil, in a porcelain dish, a small quantity of the ore with sulphuric acid, diluted with one half water. If a deep blue solution is obtained the operation may be repeated on a weighed portion, after which the solution may be evaporated to dryness and weighed. And thus an idea can be gained of the quantity of sulphate the ore will yield. Say the weight of the ore taken was 100 grams, and the sulphate obtained was 76 grams, then 76+20=1520 in pounds that a ton of the ore would yield by such treatment on a large scale, if a fair sample has been operated on. Large quantities of sulphate copper are made from old copper plates taken from ships. The same plan may be pursued to work plates from sluices and batteries and recover the gold they contain. There are several ways of working these plates.

The copper sheets can be dissolved in concentrated sulphuric acid by boiling in a cast-iron pot which strong acid does not attack. The gold, if any, will be found in the bottom of the pot as a black powder, which may be washed and melted. The copper solution can be run into lead pans concentrated to 30°, crystallized, and the mother liquid evaporated. Sometimes copper plates are heated red hot in a reverberatory furnace, drawn out when hot and hammered to remove the oxide; this being repeated until the whole sheet is oxidized. Steam is sometimes blown in to assist the process. The oxide is easily dissolved in diluted sulphuric acid. Sometimes sulphur is thrown in and the furnace closed and the sulphuret decomposed by boiling in sulphuric acid. When the sulphate is dissolved the plates are returned to the furnace, more sulphur added, and the operation repeated until the sheets are all dissolved.

Another method is to make a succession of lead-lined tanks, one above the other. These are loosely filled with sheets of copper; they are all furnished with perforated bottoms; diluted sulphuric acid is pumped up into the upper one and showered over the copper from a rose sprinkler; this passes down through the other tanks and is again pumped up several times a day. The solution soon assumes a blue color, and gains strength. By this method the copper is in a short time dissolved; when the acid becomes saturated more must be added.

41. COPPERAS. Etym. *Cuprosa* (Lat.). Coquimbite, in part Hydrous Sulphate of Iron.

Sulphate of iron occurs in several localities in the State, and is generally the result of solfataric action, as at the Sulphur Bank in Lake County, where it is very abundant. No analysis has been made of it, so that its exact composition is unknown. Dr. Trask, in his report of 1854, fol. 56, says it is found in large quantities near the town of Santa Cruz; in such quantity that it could be extensively manufactured as an article of commerce. I formed the same opinion as to the sulphur bank before mentioned. Sulphate of iron is valuable as a disinfectant, as a source of sulphuric acid, and Venetian red. It is also used in dyeing, bleaching, the manufacture of ink, and in chemical operations. The estimated production of sulphate of iron in the United States in 1882, was 15,000,000 pounds. The operation of making it from the crude material is easy. It is simply required to leach it out of the earth, and crystallize it in suitable tanks. It has been mentioned elsewhere that large quantities of this material were wasted in the production of metallic copper from the mutual exchange of elements, when metallic iron is placed in a solution of sulphate of copper, at the extensive works in Calaveras County. In other places sulphate of iron could also be obtained from the refuse of the chlorination treatment of sulphides from the gold mines in the State. A sample of saturated solution of sulphate of iron was sent to the Mining Bureau recently, leached from ground sulphides that the party who sent it states could be obtained at the rate of seventy gallons per ton. This is only another evidence of the enormous waste that is permitted in the metallurgy of ores in California.

Copper—Blue Carbonate—see Azurite.

Copper Glance—see Chalcosite.

Copper—Green Carbonate—see Malachite.

42. CORUNDUM. Etym. *Kurand* (Hindoo).

This mineral is composed of alumina. When pure it is sapphire, ruby, oriental topaz, oriental emerald, oriental amethyst, etc. When combined with manganese and other impurities it becomes emery, very valuable for the manufacture of emery wheels, and cloth, and whetstones for grinding, and for grinding and polishing in a powdered state. According to Baron Richthoven it is found in the drift in the San Francisquito Pass, Los Angeles County, California.

43. CUBAN. Etym. *Cuba.*

This mineral sulphate of copper and iron resembles chalcopyrite in composition. It has a brownish appearance, and it is said to be found on Santa Rosa Creek, San Luis Obispo County. One mass weighed 1,000 pounds. I consider this statement as doubtful.

44. CUPRITE. Etym. *Cuprum*, copper (Latin). Red Oxide of Copper.

Copper	88.8
Oxygen	11.2
	100.0

H=3.5—4, sp. gr.=5.85—6.15. Color red, almost vermilion red in some specimens, in others of a darker shade. Sometimes earthy and of brick-red color (tile ore); when mixed with oxide of iron nearly black. B. B. on ch. easily reduced to a globule of copper; wet with hydrochloric acid colors R. F. blue. Cuprite is rather a common mineral in California. It is found with native copper in the Pearl copper mine, Del Norte County; near St. Helena, Napa County, in masses of considerable size, with native copper; with malachite and calcite at the San Emedio Ranch, Coast Range; at the May Flower mine, Mineral King district, Tulare County; in microscopic crystals in the Peck mine, Copper Hill, Shasta County; on the borders of Mono Lake, Mono County; at the Candace mine, Colusa County; and near Lincoln, Placer County.

(3369) is from the Reward mine, Plumas County.

(3714) is from the Mammoth copper mine, Mono County.

(4456) with native copper, from Trinity County.

(4653) with native copper, from Meadow Lake, Nevada County.

(4746) with azurite and malachite, Kerrick mine, Mono County.

(5158) in microscopic crystals, with chrysocolla and cerargyrite, from Lundy, Mono County.

And at numerous localities in the Inyo Mountains, Mono and Inyo Counties.

According to Blake, it occurs sparingly in thin crusts and sheets with the surface ores of the principal copper mines in Calaveras County, especially the Union and the Keystone; in Mariposa County, at La Victoire mine, with green and blue carbonates of copper; in Del Norte County, at the Evoca, Alta, and other mines, in very good cabinet specimens, the cavities being lined with crystal; in Plumas County, and in the upper parts of most of the copper veins of the State.

45. CUPROSCHEELITE.

This mineral is a tungstate of lime and copper, first discovered by Prof. J. D. Whitney in 1863, and described in the Proceedings of the California Academy of Sciences, vol. 3, fol. 287. It has been found massive, and in well defined crystals. Homogeneous, yellowish-green color. Luster, vitreous. H=5.5., sp. gr.=5.863. Streak, white. Anhydrous. Fusible; after heating turns purple. B. B. dissolves in borax to opaque white bead; dissolves in microcosmic salt with green color, both hot and cold. It is insoluble in water, hydrochloric acid, or aqua regia. Even after fusion with bisulphate of potash, a dense golden-yellow powder remains in either case. Fused with 1 part of nitrate of potash, 2 parts of carbonate of potash, and 2 parts of carbonate of soda, it becomes soluble; the portion insoluble in water being wholly soluble in hydrochloric acid. When first found it was supposed to be a mechanical mixture of scheelite with some copper mineral, but a close examination under the microscope shows it to be perfectly homogeneous. A large crystal was found in Kern County, which would hardly occur in a mechanical mixture of two minerals. The specimen described by Prof. Whitney was from Lower California, of which the following is an analysis:

Tungstic acid	79.69
Oxide of copper	6.77
Lime	10.95
Protoxide of iron	.31
Water	1.40
	99.12

It has since been found in the Green Monster copper mine, Kern County, about twelve miles east of White River Post Office. Cuproscheelite is generally found with black tourmaline. No. 3666, also from Kern County, has this mineral as an associate. As a source of tungstic acid it would be valuable if found in sufficient quantity.

46. DATOLITE, OR DATHOLITE. Etym. "*To Divide*" (Greek).

So named from the granular structure of certain varieties. It is a silicate of lime, containing from eighteen to twenty-two per cent of boracic acid, found in trappean rocks—gneiss, diorite, and serpentine. It is a probable source of boracic acid resulting from the decomposition of rocks.

This mineral has, as yet, been found at one locality only, but from the universal distribution of boracic acid in the State, it is likely to be found elsewhere. The locality (of the specimen No. 2190) is a mining tunnel near San Carlos, Inyo County. It occurs with grossularite in fine crystals, the datholite being the matrix in which the grossularite is imbedded. This mineral was first noticed by the late J. Lawrence Smith and an account of it published in the American Journal of Science a number of years ago.

47. DIALLOGITE. Etym. *doubtful* (Greek). Rhodochrosite, Carbonate of Manganese.

This mineral is represented in the State Museum by a single specimen, No. 3584, in beautiful pink crystals from the Colorado mine, No. 2, Monitor District, Alpine County.

48. DIAMOND.

The name diamond is a corruption of "adamas" or "adamant," derived from two Greek words, meaning "I conquer," referring to its excessive hardness. It is pure carbon crystallized. Chemically it does not differ from charcoal, and is also nearly identical in composition with graphite. It is the hardest of all known substances. Its specific gravity is 3.529 to 3.55. Diamonds are not always colorless, and this fact renders their determination difficult. They are sometimes tinged yellow, red, orange, green, brown, blue, rose-red, and often black. When the color is decided they are more valuable than when limpid. When light colored, they are said to be "off color." The fracture of the diamond is fourfold, parallel to the faces of the octahedron. The fragments are octahedral or tetrahedral. It strikes fire with steel, the surface is often rough or striated, sometimes covered with a scaly crust. The touch of the diamond is cold. When the cut gem is breathed upon the luster is lost for a moment, when defects are seen.

Sir David Brewster found cavities in the Kohinoor, and other large diamonds, with the microscope. Black diamonds he found to be opaque from a multitude of such cavities. One large diamond having a black spot in it was cut in two, and the defect was found to be vegetable mud inclosed in the crystal.

There is a peculiar appearance about a rough diamond which can hardly be described. No written description would convey to the reader a correct idea of what it is exactly like. It is easy to say that they possess a peculiar luster, like spermaceti, but who would feel certain of the identity of a diamond from such a description? Once seen, this peculiar luster becomes impressed on the mind. To educate the eye, models of rough diamonds are made at Amsterdam for the use of prospectors, and they are found extremely useful.

The diamond crystallizes in the isometric system. Sometimes crystals show the impression of other crystals upon their faces. The Indian diamonds are generally octahedral; those from Brazil dodecahedral. It has been found massive in Brazil. In this form it cuts glass, scratches quartz and topaz, has a specific gravity of 3.27 to 3.52, and is nearly pure carbon, being completely consumed in oxygen gas. It occurs in kidney-shaped, irregular masses, exterior generally black, sometimes resembling graphite, has a somewhat resinous luster, and sometimes takes very singular forms. The outer coating black and resinous interior crystalline, vitreous and lamellar, like the diamond. It has been used in powder to cut other diamonds. The diamond cutters call this variety "cheese stones."

Black diamonds are sometimes called "carbonate," or "carbonado." They are even harder than the crystallized stones. They are found in mammillary masses, sometimes 1,000 carats in weight.

The diamond is supposed to be of vegetable origin, and is believed, by those who have studied it carefully, to be produced by slow decomposition of vegetation or bituminous matters. It is generally colorless, but always transparent (except in case of the black diamond), and often found in rounded masses, occasionally in curious, irregular, concretionary forms, like chalcedony, or semi-opal. Generally the faces of the crystals are curved; sometimes they take a nearly spherical form, having forty-eight faces.

The diamond exhibits a beautiful play of colors in the direct rays of the sun or bright artificial light. To its luster has been given the name of "diamond," or "adamantine luster." Its refraction is simple, but it possesses this power in a higher degree than most other minerals of equal specific gravity. In consequence of its extreme hardness, it can only be cut by its own powder. The common saying "diamond cut diamond," is exceedingly expressive. When rubbed it becomes positively electrical, even before being cut, in which it differs from all other gems. When, after exposure to direct sunlight, it is suddenly placed in darkness, it shows phosphorescence, and the evolution of light continues for some time. It is not acted upon by any acid or alkali, but it may be consumed and completely oxidized to carbonic acid at a high heat in the atmosphere. It is so difficult to burn that the ordinary blowpipe flame has no effect upon it. It may be heated to whiteness in a closed crucible without change, but it begins to burn in a muffle at the melting point of silver. At a high heat, with nitrate of potash, it is rapidly decomposed. A diamond may be burned away on a piece of platinum in the flame of a powerful blast blowpipe.

Newton first suggested the probability of the diamond being combustible. He was led to this opinion by observing its power of refracting light so strongly. It was in 1675 that he advanced this theory. In 1694, the members of the Academy of Florence succeeded by means of powerful lenses in consuming diamonds. Lavoisier and others proved that the diamond was not evaporated, as supposed by the Academicians, but was actually burned. Lavoisier found by his experiment that if air was excluded, no decomposition took place. He burned diamonds in close vessels with powerful burning glasses, and found that carbonic acid was produced, and discovered and announced the striking similarity between their nature and that of charcoal.

Sir George McKenzie found that they could be consumed in a common muffle. In 1797, Mr. Tennant made a decisive experiment, by placing a diamond, the weight of which was noted, into a tube of gold with nitrate of potash. The tube was subjected to great heat, which was maintained some time. The diamond was oxidized at the expense of the niter. The carbonic acid evolved was conducted into lime water, and the precipitated carbonate of lime weighed. It was found to be equivalent to carbon, equal to the weight of the diamond consumed, proving it to be pure carbon.

The diamond may be burned in oxygen by suspending it in a glass globe filled with that gas. The stone is held suspended in a coil of fine platinum wire, which is made red hot by passing a current of electricity through it. The diamond soon begins to burn, and is wholly consumed. Lime water or baryta water is then shaken in the globe, when a precipitate of carbonate of lime or baryta is formed, which dissolves with effervescence in dilute acids.

The diamond can be fused by the action of a powerful galvanic battery. Experiments made with a view to prove this resulted in the fusion of six small diamonds in seven and one half minutes. On exposure to the greatest heat, they first changed to charcoal, then to graphite, after which they fused into globules. These experiments led to the conclusion that the diamond is not produced by the action of intense heat on vegetable or organic substances, which is a favorite theory. The diamond is a non-conductor of electricity. After a great fire in Hamburg, diamonds were sold for small sums, which had turned black, but, upon being repolished, they became again as brilliant as ever.

With the information given in this paper, and the specimen in the State Museum, miners and prospectors should be able to recognize diamonds if they find them in their claims, and as it is more than possible that gems of great value may be discovered, it will be well to observe the following rules in dealing with such discoveries:

When a stone supposed to be a diamond is found, do not attempt to test its hardness, even by gentle blows with a hammer. To properly do this, a small emery wheel may be used. Any miner can send to San Francisco, or elsewhere, and have such a wheel sent to him by mail. A suitable size would be one about two inches in diameter and one quarter of an inch in thickness. Such wheels are used by dentists and jewelers, and may be obtained from dealers in such goods. The wheel may be laid on the table flat, and the stone rubbed on it. If the stone is worn away in the least degree, it is not a diamond. By this simple test, the question may be answered in numerous cases. Should the stone resist the emery wheel, it *may* be a diamond; but this is not certain, for other stones will also stand this test.

The diamond is generally, if not invariably, found associated with a peculiar granular laminated quartz rock or sandstone, to which the name of itacolumite has been given. According to Dana it owes its lamination to a little talc or mica. This rock is found in Brazil, in the Urals, and in North Carolina and Georgia. A specimen from the latter locality may be seen in the State Museum—catalogue number 1371. It is five inches long, and so flexible that it may be bent a quarter of an inch without breaking. As far as I know, this rock has not been found in California. Professor Whitney does not mention it in either his volume on general geology or his auriferous gravels. I have looked for it at the localities of the diamond that I have visited, and have made many inquiries, but as yet without success.

Diamonds are found in Brazil, in beds of gravelly conglomerate called "cascalho," frequently cemented by oxide of iron, and from description, resembling some of the cemented gravels so common in the hydraulic and drift mines of California. In such an iron cemented formation a negro slave in Brazil found a bed or cluster of diamonds—probably in place—which sold for $1,500,000. Shortly after the discovery of the African diamond fields, Mr. J. H. Reily, who returned from thence, brought to California samples of the gravels associated with diamonds, which are probably preserved in some collection in the State.

Platinum, gold, rutile, zircon, quartz, feldspar, brookite, diaspore, magnetite, and yttria minerals are almost always the associates of the diamond. Some platinum has been found in Georgia and North Carolina, where a few diamonds have also been found.

Humboldt, in one of his works ("Essay on the Bearing of Rocks"), calls attention to the fact that gold, platinum, and diamonds are associates in various parts of the globe—in some places gold, platinum, and palladium; in others, gold, platinum, and diamonds. In the River Aboite, in Brazil, diamonds are found with platinum; near Tejuca, with platinum and gold. These facts awakened in him the strongest hope of finding diamonds in the Ural, where the association of these metals is known to exist. When he arrived at any of the works, he caused the gold sands to be examined microscopically, and if gold and platinum were found, he directed the workmen to look carefully for diamonds. These examinations led to the discovery of microscopic crystals, previously unknown in the gold sands of the Ural—such crystals, as in Brazil, occurred with gold, platinum, and diamonds.

The truth of Humboldt's theory as to the existence of diamonds in the gold sands of the Ural was proved by the subsequent discovery of a valuable stone by Paul Popoff, a boy of fourteen years, to whom belongs the honor. It was at first supposed to be a topaz, but a young Freiberg student, a Mr. Schmidt, who had the necessary instruments to test the hardness and specific gravity, identified it as a true diamond. Two others were soon afterwards found, the third being larger than both the others, followed by systematic search, which has since produced many valuable stones.

Diamonds found in river beds are generally in amorphous, while those found embedded in the formations peculiar to their locality are covered with an earthy pale gray, yellow, or rose-red coating. The texture of the diamond is lamellar.

The early history of the diamond is obscure. There seem to have been stones of quite different nature known to the ancients as "adamas." Pliny says: "Adamas is a mineral which for a long time was known to kings only, and to but few of them. The ancients supposed that adamas was only to be discovered in the mines of Æthiopia, between the temple of Mercury and the Island of Meroe, and they have informed us that it was never larger than a cucumber, or differed at all from it in color."

It is very certain that Pliny knew but little of the matter, for he describes six varieties, all of which, according to his description, possessed properties not found in the diamond, but he becomes absurd when he says that the diamond, "which resists every force of nature, is made to yield before the blood of a he goat." To those who wish to verify this reaction he gives the following advice: "The blood, however, must be warm; the stone, too, must be well steeped in it, and then subjected to repeated blows."

Allusions met with in their ancient mythology lead to the supposition that the Hindoos were in possession of gems and held them in high estimation.

According to Jewish history as set forth in the Bible, the diamond was one of the twelve gems set in the breastplate of the high priest. But to my surprise I find that Josephus denies this indirectly. As the discrepancy is remarkable, I have given both authorities:

Bible.		Josephus.	
1	Sardius	1	Sardonyx
2	Topaz	2	Topaz
3	Carbuncle	3	Emerald
4	Emerald	4	Carbuncle
5	Sapphire	5	Jasper
6	Diamond	6	Sapphire
7	Ligure	7	Ligure
8	Agate	8	Amethyst
9	Amethyst	9	Agate
10	Beryl	10	*Chrysolite*
11	Onyx	11	Onyx
12	Jasper	12	Beryl

It will be seen that in the list given by Josephus that the arrangement is different, and that the chrysolite replaces the diamond. According to the Bible, the diamond was one of the precious stones worn by the king of Tyre.

History shows that the ancients attributed great medicinal powers to gems. They were worn also as a protection against all forms of evil, some in a vague general way, while others were regarded as antagonistic to special diseases or accidents. Pliny claims for the diamond that it will "overcome and neutralize poisons, dispel delirium, and banish groundless perturbations of mind." Less than a century ago diamonds were borrowed from rich families to act as a cure for certain diseases. It is said that to prevent them being swallowed by the patient they were secured by a string when placed in the mouth.

Plato and Pythagoras must have known something of gems and crystals, as they have beautifully written how "Nature, in the dark recesses of the earth, occupies her time in working out geometrical problems."

It is a curious historical fact that when, during the French revolution, the diamonds of the rich were given to the people, it was found that many of them were imitation.

Until quite recently the chemical composition of the diamond was unknown, nor could it be cut by any means known. It was worn as found, and was consequently inferior in appearance to those we see in our day. As soon as its chemical nature was discovered, attempts were made to produce it artificially in the laboratory, but up to the present day with only partial success.

The first diamonds came from India. The famous mines of Golconda are situated between Hydrabad and Masulipatam. Other localities in India have produced large quantities. It is said that Sultan Mahmoud, when he died, left 400 pounds of diamonds. These diamond fields are now exhausted and seldom produce any stones of value.

Diamonds were discovered in Brazil in 1728. They had always been thrown aside as useless in gold washing, until one who had seen this gem in the rough state quietly collected a large quantity of them, from the sale of which, in Portugal, he realized a fortune. They are found in an alluvial soil, in the district of Cerro di Fria, Minas Geraes, San Paulo, and in other localities. Those Californians who have visited Rio Janeiro will remember the gorgeous display of diamonds in the shop windows—the product of these mines. It is said that Brazil has produced over two tons of diamonds. When the Brazilian diamond fields were opened, it was not believed in England; but it was thought that Indian diamonds had been sent to Brazil, and from thence to England. The mines of Borneo have produced but few large diamonds, but great quantities of small ones. The amount of annual production credited to that island is 2,000 carats$=1.\frac{143}{1000}+$ lbs. avoirdupois. There have been two panics in the price of diamonds; the first when it was known that Brazil was producing large quantities of this gem, and the other at the time of the French revolution. At these periods the prices of diamonds fluctuated in the strangest manner.

The discovery of unusually large deposits of diamonds in South Africa in the year 1867 caused considerable commotion in the diamond trade. In 1880 the gross weight of diamonds that passed through the Post Office at Kimberley was 1,440 pounds and 12 ounces avoirdupois, the estimated value of which was $16,000,000. At the end of 1880, 22,000 blacks and 1,700 white men were employed in the diamond fields of South Africa; 250 men were engaged in diamond mining on the Vaal River the same year.

From Kimberley and Old De Beer's mines alone diamonds to the amount of 3,000,000 carats are annually raised. The other mines produced 300,000 carats in 1880.

According to Professor Tennant, ten per cent of the Cape diamonds are first class, fifteen per cent second class, twenty per cent of the third; the remainder being of the quality known as *bort*, and are useful only to cut other diamonds, and for glaziers' diamonds, rock drills, etc.

The most valuable diamond found in the United States was discovered in 1856 on the banks of the James River, opposite Richmond, Virginia; its weight was 23.7 carats (ninety-nine grains).

REMARKABLE DIAMONDS.

A diamond over ten carats in weight is called a "princely" diamond; only one in about 10,000 can lay claim to this distinction. There are eight diamonds which, being of unusual size and splendor, are called "sovereigns." All of them are more than one hundred carats in weight. The following is a list of the sovereigns, and the most celebrated of the princely diamonds known:

No.	NAME.	Carats.	No.	NAME.	Carats.
	Sovereigns.			*Princely Diamonds.*	
1	Braganza*	1880	9	Piggott	$82\frac{1}{4}$
2	Mattam	367	10	Shah	86
3	Great Mogul	$297\frac{3}{16}$	11	Nassak	$78\frac{3}{8}$
4	Orloff	$194\frac{1}{4}$	12	Bryce Wright	$66\frac{1}{2}$
5	Florentine, or Toscanor	$139\frac{1}{2}$	13	Sancy	$53\frac{1}{2}$
6	Regent, or Pitt	$136\frac{3}{4}$	14	Eugene	51
7	Star of the South	125	15	Hope (blue)	$44\frac{1}{2}$
8	Kohinoor	$106\frac{1}{16}$	16	Pasha of Egypt	40
			17	Cumberland	32
			18	Polar Star	-------

* Thought to be a Topaz.

There are others which could be mentioned, but the above table includes all those of special interest. A green diamond at Dresden weighs forty-eight and a half carats, and is said to possess remarkable brilliancy and beauty. The celebrated French blue diamond was lost in the revolution and never found.

Diamond cutting not only requires great skill and judgment, but also the outlay of considerable capital. The largest establishments for this branch of industry are in Amsterdam. In the year 1872 I visited the works of M. & E. Coster, in that city, and saw the whole operation. The building is a large brick structure, every part of which is devoted to some branch of the trade. A beautiful and powerful engine in the basement drives the machinery. Vertical shafts pass up to the top of the building, and from these the grinding discs are geared.

I was first shown the room where the diamonds are kept for safety, and had the opportunity of seeing some fine stones. From this room I was shown to another where the diamonds are split. This is a curious and delicate operation. Only workmen of great experience are allowed to attempt this work.

The rough diamond is taken up by one of the workmen in this room, who studies it carefully, calculates mentally what parts can be removed without detracting from the value of the stone, keeping in mind the rule, that the value of a rough diamond is only that of the largest doubly truncated perfect octahedron that it will make. All excess must be removed. It is a great advantage to split off fragments, for the double reason that the larger fragments may be cut with profit into small stones, to set around opals or pearls, and because it is a great economy of time, as the grinding down of the stone is a slow and tedious operation. It sometimes becomes necessary to remove flaws by this operation.

The workman is well aware of the fact I have already stated, that the cleavage of the diamond is fourfold, and takes of it every advantage. It is astonishing to witness the skill with which the operation is performed. A workman cements the stone to a piece of compact wood by means of strong cement, leaving the portion to be removed exposed. To this end he fashions the cement with his fingers, while still soft, then with a fragment of another diamond he makes a deep scratch along the line of cleavage. Then, after wrapping the stone in loose folds of cloth, he applies a steel rule or knife, and with a gentle and skillful blow with a light rod of steel, he breaks off the portion he wishes to remove with unerring certainty.

From the hands of this workman the stone passes to another in a second room, who continues the operation by cementing it again to the end of a stick, and taking another diamond of equal size, also cemented in the same manner to a stick, he rubs the two together until he produces the proper facets on each—each grinding the other down. The workman to whom this operation is intrusted wears heavy leather gloves. The powder resulting from the abrasion is carefully collected in a box, in which oil is kept, which collects the dust, and prevents it from being blown away. When sufficient has collected, the oil is burned away, leaving a gray powder called "bort," which is more finely powdered, and used to polish other diamonds. During the operation of grinding, the workman frequently touches the stone to his tongue, to see how the operation progresses; first, however, removing any adhering diamond dust with a camel's hair brush. This work does not form all the facets of a perfect stone.

The next and last operation is that of polishing the rough cut stone, and of cutting away some of the edges, producing a new set of facets, due to a perfectly cut brilliant.

The polishing is done on discs of iron or steel. These wheels are about three feet in diameter, and rotate horizontally. They move with great velocity, making two thousand revolutions in a minute. They are so true, and run so smoothly, that at first glance they seem like stationary tables, sustained by the vertical shafts. It requires some skill and labor to prepare the surface of these discs to render them suitable for receiving the diamond powder. Stones of varying fineness are used in such a manner as to leave striæ on the surface, something like that of the burr millstone, but very much finer. A mixture of diamond dust and olive oil is then placed on the face of the disc, which is called a "skaif." The workman then takes a brass tripod, of which one arm is longer than the others; in the end of this longer part there is a socket, which he fills with melted solder, into which, as it cools, he imbeds the stone, leaving the face only exposed which he wishes to polish. When the solder is perfectly cold and hard, he turns the stone down on the revolving plate, allowing the shorter arms to act as a claw to hold against the friction of the wheel.

He then puts weights on the end of the tripod above the stone. These are heavy or light, as the face is large or small.

The Amsterdam establishment employs from five hundred to six hundred persons. An establishment for diamond cutting has lately been started in New York, under the name of the New York Diamond Company. For many years diamonds have been cut and polished in Boston, and quite recently the English have turned their attention to the art in which they once excelled.

It requires practice to judge of the diamond in its rough state. A rough diamond of the first water would be hardly recognized by the uneducated eye as a valuable gem. In describing the diamond, many of its characteristics are visible only in its cut state. Half the stone is sometimes cut away before a perfect gem can be produced. The diamond washers of Brazil rub the stones together and produce a peculiar grating sound, by which they claim to judge of their value.

There are three modes of cutting the diamond; the rose, the brilliant, and the cabochon. The shape of the rough stone, and the taste or want of taste of the owner, determines which style shall be adopted. The art of cutting diamonds by their own powder originated with Louis Berghen, of Bruges, in the year 1476. At first the style was a flat table, with facets on the edges. The brilliant was invented during the reign of Louis XII. Cardinal Mazarin is said to have been the first who had diamonds cut in that form.

The cutting of the brilliant is governed by certain rigid rules, the slightest deviation from which produces an imperfect gem. David Jeffries, who published a treatise on diamonds and pearls in London in 1750, a copy of which may be found in the library of the State Mining Bureau, gives the rules in detail, illustrated by diagrams. The work also gives tables for valuing diamonds from one to one hundred carats, increasing by eighths of carats.

The stone is first reduced to a perfect octahedron, in which all the axes are equal. Setting one axis vertical, he divides it into eighteen imaginary equal parts. The edges at which the pyramids meet is called the "girdle." The upper part of the octahedron is cut off at the fifth division from the top and parallel to the girdle, forming the face, which is called the "table." The bottom part of the stone is then cut off at the first division, leaving a small face called the "collet;" the remainder is then a perfect square brilliant. The edges and solid angles are then cut into a number of facets and highly polished, and the brilliant is finished.

Sometimes to make a diamond appear larger the angle of the crystal is made greater than ninety degrees. Such a stone, wanting in depth, is deficient in brilliancy, although appearing larger than a perfectly proportioned stone. Such diamonds are called "spread brilliants." In other cases, for certain reasons, the angle is less than ninety degrees. The table is then smaller than it should be, and is unsatisfactory to the educated eye. Jeffries' tables for valuing stones is used as follows: Suppose the reader has a diamond which weighs four and one eighth carats, and wishes to ascertain if it has been properly cut. With a pair of small calipers he takes the width of the diamond and compares it with the model of a brilliant of the same weight in the table. Then with the calipers he takes the thickness of the stone, from table to collet, and compares it with the bar below the model. Lastly, he measures the size of the collet; if the diamond is badly cut the defect will be seen at once. These tables are much used, and may be found in works on diamonds and precious stones.

Diamonds are valued according to weight, purity of color, freedom from defects, etc. Much depends also on the state of the country where they are for sale. When times are prosperous and money plenty, they will find a readier sale than when the reverse is the case. There is no rule which gives the absolute value of first-class diamonds. But the trade is governed to a great extent by the formula devised by Jeffries, to whose work I have before alluded. His tables assume that diamonds increase in value proportionally to their increase in size. At the time his tables were calculated it was assumed that rough diamonds, both good and bad, averaged ten dollars (two pounds sterling) per carat. (One carat equals four grains.) To ascertain the value of any rough diamond he multiplied the square of its weight by the value of one carat. Thus, if a rough diamond weighed five carats, its weight would be 5×5×$10=$250.

A cut stone was calculated differently. It was taken for granted that a rough diamond loses half its weight in cutting, therefore the calculation was made on the value of a rough stone of double the weight; for example: for a cut stone of five carats, 10×10×$10=$1,000, and to this price was added the cost of cutting. The best glazier's diamonds are worth fifty dollars per carat, but few being fitted for that purpose.

The value of fine diamonds has largely increased since Jeffries' time, 1750, and in 1865 a diamond of five carats was worth in London £350, or $1,750, reckoning the pound at five dollars. The same authority from which I take this valuation says that the stone must be free from the faintest tinge of color, from any flaws, specks, marks, or fissures of any sort, must be bright and lively, and free from what is technically called "milk" or "salt." The stone must also be cut in perfect proportion, according to the rules before given. This author also says that it is impossible to calculate the value of a stone above five carats, as the price then depends wholly upon supply and demand. When a diamond has a decided color it is called a fancy stone, and will bring a very high price.

Unfortunately, the temptation to produce large-surfaced stones at the expense of the rules of the true proportion is so great that perfectly cut stones are seldom seen.

The existence of diamonds in California was early known. In the Annual of Scientific Discovery for 1850, in an article quoted from Silliman's Journal, may be found a statement to the effect that the Rev. Mr. Lyman, formerly from New England, saw a crystal in California of a light straw color, having the usual convex faces, and about the size of a small pea. He saw the crystal but for a few minutes, and had no opportunity for close examination, but the appearance and form left little doubt that it was a true diamond. From that time to the present, diamonds have been occasionally found in the State.

Mr. W. A. Goodyear is quoted in Whitney's "Auriferous Gravels of the Sierra Nevada of California" as follows: "He saw a diamond in the possession of Mrs. Olmstead, at Dirty Flat, near Placerville, El Dorado County, which measured nine thirty-seconds of an inch maximum diameter, and weighed one and a quarter carats—$5\frac{61}{100}$ grains. It was found by Mr. Olmstead in cleaning up the sluices of the Cruson tunnel, Dirty Flat." The same stone is mentioned in Mr. Carpender's letter.

At the McConnell & Reed claim, on the south side of Webber Hill, a diamond the size of a small white bean was found. This diamond was discovered a few feet above the bedrock. Mr. McConnell thinks on a previous occasion he had thrown away a diamond as large as the end of his thumb, in ignorance of its true character. Two other diamonds were found in another claim, also on the south side of Webber Hill.

Three or four diamonds were found near White Rock. Mr. Goodyear purchased a crystal of Mr. Thomas Potts. It weighed half a carat—two grains; had a slight yellowish tinge, and was found in washing the gravel which came from a tunnel driven into White Rock. (See Mr. Carpender's letter.) Near the same locality three diamonds were found in gravel by the Wood Brothers, in 1867. The largest was valued by a San Francisco dealer at fifty dollars. The same authority gives the following localities of California diamonds: Jackass Gulch, near Volcano, Amador County; Indian Gulch, Loafer Hill, near Fiddletown, Amador County; French Corral, Nevada County, one specimen weighing seven and one half grains.

Diamonds have been found at Volcano, in Amador County, in a peculiar volcanic formation, described by Professor Whitney as "ashes and pumice cemented and stratified by water." The crystals had the form of the icositetrahedron, with faces curved in the manner peculiar to the diamond.

A formation occurs at Cherokee, Butte County, above the bedrock, which has the appearance of being the same volcanic mud to which I have before alluded, and somewhat resembling the deposit at Volcano, which I have seen and examined. Strong evidence that the so called white lava was not an igneous flow, and that it was at one time soft and plastic, is shown by the leaf impressions (Museum specimen No. 4219) presented by Dr. William Jones, and obtained two miles from San Andreas, Calaveras County. If the "lava" had been hot, it would have burned the leaves before they could have made any impression, and if the formation had been at all indurated the leaves could not have imbedded themselves, as shown in the specimen. With all our investigation and theories, we have much to learn concerning the auriferous gravels of California, their interesting mineral associates, and the geology of their deposition and occurrence.

Knowing that diamonds had been found at or near Placerville, and not having time to visit the locality, I addressed a letter to Mr. A. J. Lowry, Postmaster at Placerville, asking information, and in due time received the following reply:

Placerville, September 12, 1882.

Henry G. Hanks, State Mineralogist:

Dear Sir: Your letter of August nineteenth, to Postmaster Lowry, of this place, asking for information as to the finding of diamonds near Placerville, has been handed to me, with the request that I answer it.

In 1871, Mr. W. A. Goodyear, Assistant State Geologist, while examining the deposits of auriferous gravels in the ancient river bed, about three miles east of Placerville, found several specimens of itacolumite, and expressed the opinion that diamonds should be found in the gravels. I assisted him in searching for them, and we found several in the hands of the miners. Mr. Goodyear bought one of them as a geological specimen. None of the parties who had them knew what they were, but had kept them as curiosities. The gravel in the channel is capped with lava from 50 to 450 feet in depth. Of late years the gravel is worked by stamp gravel mills, and I know of instances where fragments of broken diamonds have been found in panning out the batteries.

I give you the names of the finders of several diamonds in this vicinity, namely:

Charles Reed, one.

Mr. Jeffreys, one.

Thomas Ward & Co., three—Two white; one yellow. One of these is now in the possession of Mr. Ashcroft, of Oakland, who had it cut in England.

Cruson & Olmstead, four—One of which Olmstead sold to Tucker of San Francisco. It measured nine thirty-seconds of an inch in diameter, was pure, and nearly round. I think he got about $300 for it.

Thomas Potts, one—Which he sold to Mr. Goodyear for fifteen dollars. It was small, and flawed.

Jacob Lyon, one—Light straw colored, about the size of a medium-sized pea; also, several fragments obtained from the tailings of a gravel mill at the Lyon Mine.

A. Brooks, one—Small white.

F. Benfeldt, one—Small yellow, weighs two grains. It passed through a gravel mill.

The diamond mentioned in your letter as being "found by a lady in a dump at the mouth of a shaft," was probably the one found by Mrs. Henderson, in some tailings that had been washed for gold.

Yours, truly,

W. P. CARPENDER.

Mr. Melville Attwood was among the first to predict the discovery of diamonds in California. The following is an extract from a newspaper article written by him in 1854:

I am anxious to call attention to the chance of finding diamonds in this country, and the likelihood of their being overlooked. The rocks in which they occur are common in California. Itacolumite, a soft micaceous sandstone, always the associate of the diamond, is also found here. The gravel always found in the river washings so closely resembles the "cascalho," or "diamond gravel" of Brazil, that I think it very probable that if proper search was made diamonds would be found.

Mr. Attwood spent several years in the diamond districts of Brazil, and is familiar with the subject of which he wrote.

In August of this year I visited Cherokee, Butte County, specially to study that celebrated diamond locality. Mr. A. McDermott, druggist of Oroville, says that a diamond was sent to him in 1862 which was as large as a small pea. It was nearly globular and obscurely crystallized and of yellow color. He does not know the subsequent history of the stone, where it was found, or the owner's name.

At Cherokee, diamonds and zircons are found in cleaning up sluices and undercurrents. The first notice of diamonds at this locality dates from 1853, the largest discovered, which was two and a quarter carats (nine grains), is now in the possession of John More. There have been from fifty to sixty found, from first to last; some were rose colored, some yellow, others pure white, and all associated with zircons, platinum, iridium, magnetite, gold, and other minerals.

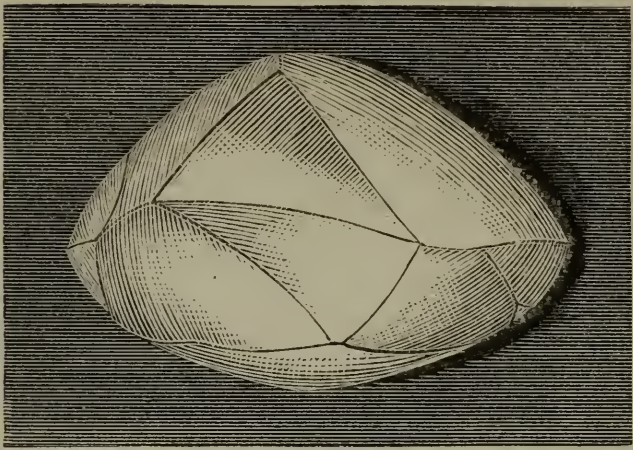
A similar association of metals occurs in the northern counties of California, especially in the region drained by the Trinity River, in the sands of which microscopic diamonds are actually found. The same may be said of the vicinity of Coos Bay, in Oregon, and along the banks of Smith River, in Del Norte County. Miners throughout this whole region, and in the hydraulic mines, should search carefully for diamonds, and should send anything they find, which is likely to be such, to the State Mineralogist for identification. Diamonds may be looked for in flumes, and in cleaning up sluices, with gold and platinum. An examination of the platinum sands of the Trinity River was made by Professor F. Woehler, of Gottingen, who found diamonds in them. After removing gold, platinum, chromic iron, silica, ruthenium, etc., by the usual methods, he examined the residue microscopically, and observed colorless, transparent grains, which he presumed to be diamonds. Subsequent combustion in oxygen and precipitation from solution of baryta, by the carbonic acid evolved, convinced him that the microscopic crystals were true diamonds. This fact is an extremely important one to the inhabitants of the Pacific Coast.

Platinum minerals have been found rather abundantly in Butte County. At St. Clair Flat, near Pence, they were collected in quantity in the early days of placer mining. They are found also at the Corbier mine, near Magalia (Dogtown). In 1861 a diamond was found one and a half miles northwest of Yankee Hill, Butte County, in cleaning up a placer mine. The stone was taken from the sluice with the gold, and sold to M. H. Wells, to whom I am indebted for this information. Mr. Wells presented the gem to John Bidwell, of Chico, who had it cut in Boston. It weighed one and a half carats—six grains. Mr. Bidwell gave the diamond to his wife, who now wears it on her finger. This was the only diamond found at the locality.

The State Museum is indebted to Mr. Louis Glass, Secretary of the Spring Valley Hydraulic Gold Company of Cherokee, for fine samples of platinum No. 4224 gold, No. 4225, and other interesting minerals from that locality.

A fine diamond from the Spring Valley mine, Cherokee, has also been presented to the State Museum No. 4033 by Mr. G. F. Williams, Superintendent, which has been placed in the Butte County case in the State Museum. Samples, also, of the gravels, and concentrations of black sands, platinum minerals, lava, bedrocks, etc., have been collected, and being now in process of arrangement, will soon be properly displayed. Samples of the interesting association of black sands described by me, and in Professor Silliman's papers, have been set aside for those who desire to make a special study of them, and to whom specimens will be sent on application. I had the pleasure of seeing a number of other diamonds from this locality during a recent visit. Mrs. Harris has a beautiful Cherokee rough diamond set in a ring. Mr. Harris, who was formerly Superintendent of the Spring Valley Hydraulic mine, has another, which has been cut. Of the two, I consider the natural crystal the most interesting and beautiful. Mrs. W. C. Hendricks, of Morris Ravine, near Oroville, also has a fine Cherokee diamond set in a ring.

A very interesting stone has lately been brought to my notice, which was found in July, 1883, by George Evans, on the surface of the ground at Rancheria, a small mining camp about four miles northwest of Volcano, Amador County. It weighs 255 milligrams. Its length is 0.315 inches; thickness, 0.215 inches. It is irregularly globular in form, all the faces being convex. Its form, magnified seven diameters, is shown in the cut. It is pale straw colored, very brilliant, and, as far as could be distinguished even under the microscope, is without a flaw.



Amador County Diamond, magnified seven diameters—drawn with camera lucida.

Miners are generally not familiar with the appearance of diamonds in the rough state, and would most likely mistake them, if found, for chalcedony or some similar mineral. If in crystal form, it would be to them a crystal only—interesting for the moment, to be soon thrown aside as useless. A case has been mentioned in which a beautiful crystal, supposed to be a diamond, being found in some placer mine in California, was put to the following test: It was placed on an anvil and struck a heavy blow with a sledge hammer, it being assumed that the diamond, being the hardest of known substances, could not be broken. This idea is more ancient than is generally supposed. The statement has been made by Pliny, but it is doubtful if he ever made the experiment himself. In speaking of Adamas, he says "it cannot be crushed, but would split hammers and anvils in the attempt." It is certain that this is a mistake. The diamond can be split on the edge of a knife, and even a light blow with a hammer might destroy the most costly gem.

49. DIATOMACEOUS EARTH.

A diatom is generally admitted to be a single-celled plant, bearing a singular relation to the animal and even to the mineral kingdom, being considered by some as belonging partly to the latter, and regarded as a vegetable crystal, differing only from minerals in having the power of locomotion and of multiplying by separation. Kutzing says: "In comparing the arguments which indicate the vegetable nature of the diatomaceæ with those which favor their animal nature, we are, of necessity, led to the latter opinion."

In connection with the idea that the diatom pertains somewhat to the mineral as well as the animal kingdom, it is a curious fact that if silica, deposited from fluoride of silicon, be crushed between plates of glass, and examined microscopically, with a medium power, markings may be seen on the outer surfaces of the vesicles which resemble those of the diatoms, especially pleurosigma and coscinodiscus. It is also remarkable that Dr. James Blake collected fifty species of living diatoms from a hot spring in Pueblo Valley, Nevada, the temperature of which was 163 F. Flint probably originates from diatoms, as does also the silica in certain rocks.

The name diatom is derived from a Greek word signifying being cut in two. Diatoms resemble the desmids, but differ in having an outer skeleton, or frustrule of silica. The frustrule of a diatom is a silicious box, always in two parts, one slipping over the other like a pill box, or with edges opposed. The thickness of a single diatom is, roughly, the sixth that of a human hair, and its weight is estimated at the 187-millionth part of a grain. Some varieties attach themselves to other bodies as the algæ, while others swim in the water free.

The study of the diatomaceæ, aside from the scientific interest, is very fascinating. Their extreme and varied beauty is a source of constant pleasure to the microscopist, and the question is often asked, why is so much beauty vailed from human sight?

The beauty of the diatoms consists in their color, their general form and sculpture, or natural markings, which characterize nearly all of them. These delicate markings are seen under the microscope to be processes, knobs, bosses, concavities, ribs, groovings, and lines, so minute that the highest powers made by the most skillful opticians are required to see them at all; even then, they can only be resolved when the apparatus is manipulated by the most skillful operators. The lines of certain diatoms have been measured and are used to test the magnifying and penetrating power of object glasses. A slide called a test plate has been prepared, on which twenty well known species are mounted, commencing with one on which the lines are comparatively coarse, and ending with one—*Amphipleura pellucida*—which has 130,000 lines to the linear inch. For the convenience of study, typical diatoms are mounted on a single glass slide, so arranged that reference can be made to a printed catalogue for the names, while in some cases the names of the species are micro-photographed on the slide.

The diatoms are placed on the plate by the aid of an ingenious device called a mechanical finger, by means of which the shells can be picked up singly and given the desired position. Moller's typen platte number one, has four groups, twenty-four lines in each, comprising about 500 individuals, of 395 distinct species and seventeen genera. The cost, with printed catalogue, is forty dollars. Some microscopists are so fond of the study of these minute forms, that they scarcely do any other work than to observe, collect, classify, and describe them.

When it is stated that the names of more than 4,000 distinct species of diatoms are given in a catalogue published by Frederick Habirshaw, of New York, each of which has some feature by which it may be distinguished; that this vast kingdom, so to speak, is invisible to the human eye, or nearly so; that when highly magnified many of the species are extremely beautiful, and all of them interesting, it is easy to understand why so much interest is taken in them the wide world over, and why every new discovery is heralded, and calls for samples come from the whole scientific world.

It is an established fact, strange as it may seem, that some of the greatest mountain chains, such as the Andes, and the very soil beneath our feet, is chiefly composed of the remains of animalcules, invisible to the eye; that is to say, the matter has been used by animated beings and returned again to the mineral kingdom, retaining the form which it assumed while a part of their minute bodies. Byron has written, with more truth than he probably realized, that "the dust we tread upon was once alive;" and the remark of Dr. Buckland is often quoted: "The remains of these minute animals have added more to the mass of minerals which compose the exterior crust of the globe than the bones of the elephants, hippopotami, and whales."

In the tertiary age, beds of diatomaceous or infusorial earth were deposited, consisting almost wholly of these microscopic organisms. The extent of some of these deposits is almost incredible, and is regarded as an evidence of the great age of the world. The Bohemian deposit in Europe is fourteen feet thick, and, by the estimation of Ehrenberg, contains 40,000,000,000 diatoms to the cubic inch.

Darwin observed in Patagonia, along the coast, for hundreds of miles in extent, a bed of tertiary sedimentary formation 800 feet in thickness, overlaid by a stratum of diatomaceous earth. At Bilin, in Austria, a bed of infusorial earth, fourteen feet thick, occurs. One merchant sells annually many hundred tons of it. The *Bergh mehl*, or mountain meal of Lapland and Norway, is from beds thirty feet in thickness. It must be remembered that these deposits extend over many thousands of square miles. Notwithstanding the astonishing fact that vast areas of the earth's surface are built of these minute forms, the true nature of these deposits was not known until 1837, when Ehrenberg published his celebrated work on that subject. The same deposition is taking place at the present time. In certain lakes in the United States and elsewhere, deposits several inches in thickness accumulate, composed wholly of the remains of recent diatoms. When thoroughly dried, a chalky powder is obtained, which, under the microscope, is easily recognized. Similar deposits have been made known by dredging the bottom of the sea.

According to Prof. Joseph Le Conte, of the California State University, in the deeper parts of Lake Tahoe, which sediments do not reach, the ooze is composed wholly of diatoms or infusorial shells.

Dusty showers of a grayish or red color are not unfrequent on the Atlantic and Indian Oceans, near the coast of Africa. Ehrenberg examined this dust, and found it to consist largely of diatoms. He estimated the quantity let fall during a dust shower in the year 1846, near Lyons, at 720,000 pounds, one eighth of which was diatomaceous, or 90,000 pounds, equal to forty-five tons. Diatomaceous earth may be distinguished from other formations of a similar appearance by its insolubility in acids, extreme lightness, power of absorbing liquids, and property of polishing metals. It is instantly recognized under the microscope in the hands of one who is familiar with its use. Diatomaceous earth has its uses as well as its scientific interest. It is largely consumed as a polishing powder, under the name of tripoli, from the locality which first gave it to commerce. It is known in California by the absurd name of *electro-silicon*, and at the East by a variety of trade names. It is a very convenient source of soluble silica, employed in the manufacture of silicate of soda or potash, also known as soluble glass. The manufacture of this compound is simplicity itself. Carbonate of soda, or potash, as the case may be, is dissolved in boiling water to saturation, in a capacious iron kettle, and fresh hydrate of lime added until all the carbonic acid is precipitated, and the alkali becomes caustic. Diatomaceous earth in a powdered state is then added as long as silica is dissolved, and the whole covered and allowed to cool. When the insoluble matters have settled, the clear liquid is drawn off and evaporated in a clean vessel to the required density.

Diatomaceous earth is also used in the manufacture of porcelain, and is a constituent of certain cements and artificial stones. At one time it was claimed to be a fertilizer, but this is thought to be a fallacy, although Ehrenberg states that the fertilizing power of the Nile mud is furnished by fossil infusoria. Slabs of diatomaceous earth absorb liquids with avidity, and are used in laboratories for drying crystals and filters. This property might be more generally utilized, if better known.

A convenient contrivance for lighting fires is a lump of diatomaceous earth with a handle of stout iron wire. It is dipped into a vessel of petroleum, placed in the stove or fireplace, and lighted with a match. It continues to burn safely for some time. It can be used again and again. No person, however, should make use of it who has not the common sense to carefully set away the vessel containing the coal oil before lighting the match.

Bricks that float in water are made of diatomaceous earth mixed with one twentieth part of clay and well burned. The art of making these floating bricks was well known in the time of Pliny, but was afterwards lost. It has recently been rediscovered. In the Italian department of the Paris Exposition of 1878, these bricks were exhibited, which attracted considerable attention. Floating bricks, made wholly of California material, may be seen in the State Museum.

Keiselghur, or "flint froth," of the Germans, from a deposit in Hanover, is extensively used in the manufacture of dynamite, giant powder, lithofracteur, and other explosives. Diatomaceous earth absorbs from three to four times its weight of nitro-glycerine, with the advantage over other absorbants of retaining the nitro-glycerine under greater pressure. Dynamite contains twenty-seven per cent and lithofracteur twenty-three per cent of diatomaceous earth. Before the keiselghur can be used, it is subjected to treatment to remove water, all organic matter, and coarse particles. It is first calcined in a succession of furnaces, crushed between rollers, and sifted. It is claimed that the diatomaceous earths of California are unfit for this purpose, but it is my opinion that they have not had a fair trial.

Diatomaceous earth is largely used in the manufacture of soap, to mechanically increase its detersive power. The Standard Company receive large quantities of it from the southern counties of the State. A polishing powder is sold in San Francisco under the name of "El Dorado Polish." It comes from Prospect Flat, three fourths of a mile from Smith's Flat, near Placerville. It is a diatomaceous earth. The deposit is called the "Silicon Lead."

Diatomaceous earth has been used with cement as a lining for fireproof safes, and in the fining of wines. It is not to be supposed that all the uses of this remarkable substance have been discovered; it remains for the intelligent inventor to search for new applications.

Diatomaceous earths are abundant in California, some of them being very interesting. The Monterey deposit has long been known to the scientific world. Dr. James Blake, who has made this subject a special study, thinks that all the California earths are of the miocene age.

The following is a list of the localities represented in the State Museum, samples of which (except the Santa Monica) will be furnished to specialists who make application for them. The numbers refer to the Museum catalogue:

35. Santa Monica, Los Angeles County.
175. Ione Valley, Amador County.

240. Los Angeles County.
436. San Gregorio, San Mateo County.
444. San Joaquin Valley, near San Carlos Ranch.
547. Seacoast, 40 miles north of San Diego.
557. Staples' Ranch, San Joaquin County.
654. Ten miles north of Petaluma, Sonoma County.
791. Santa Barbara.
830. Monterey County.
1184. Near Comanche, Calaveras County.
1246. Lost Spring Ranch, Lake County.
1284. Santa Catalina Island.
1331. Dutch Flat, Placer County.
1448. Port Harford, San Luis Obispo County.
1742. Fourteen miles below San Pedro, Los Angeles County.
1832. Eighteen miles southeast of Santa Rosa, Sonoma County.

Of all those mentioned above, the Santa Monica is the most noted. Slides of this material grace the cabinets of microscopists in all parts of the world, and yet the deposit from which it came is not known. The history of the specimen which furnished so much to science is interesting.

In March, 1876, Mr. Thomas B. Woodward, then connected with the United States Coast Survey, sent a fragment of diatomaceous earth to the California State Geological Society, which he found in tidal refuse on the seashore near Santa Monica, Los Angeles County. The piece could not have weighed more than two pounds, and had so long been subjected to the action of the waves that the edges and angles were rounded. The exact locality was two miles southeast of the lagoon, and several miles southeast of Santa Monica. He saw no other sign of a deposit of the earth. The genuine Santa Monica (which name refers to the waif) is now the most interesting of any known, and is prized above gold. Several attempts have been made to discover the origin of the fragment, but so far without success.

The following list of diatoms found in the Santa Monica will give some idea of its prolific character. The list is by no means complete, being only those identified by William J. Gray, M.D., of London, England; Charles Stodder, of Boston, Mass.; F. H. Engels, M.D., of Nevada City, Cal., and Wm. Norris, of this city. The State Mineralogist will be pleased to receive contributions to the catalogue from any diatomist who may see this article:

DIATOMS FOUND IN THE SANTA MONICA EARTH.

1. Actinophæni splendens.
2. Actinoptychus superbus.
3. Actinocyclus interpunctatus.
4. Arachnoidiscus ornatus.
5. Arachnoidiscus ehrenbergii.
6. Amphitetras elegans.
7. Amphitetras wilkesii.
8. Asterolampra variabilis.
9. Asteromphalus darwinii.
10. Auliscus elegans.
11. Auliscus mirabilis.
12. Auliscus notatus.
13. Auliscus pruinosus.
14. Auliscus racemosus.
15. Auliscus reticulatus.
16. Auliscus sculptus.
17. Auliscus hardmanianus.
18. Aulacodiscus browneii.
19. Aulacodiscus kittonii.
20. Aulacodiscus margaritaceus.
21. Aulacodiscus oregonensis.
22. Aulacodiscus pulcher.
23. Biddulphia aurita.
24. Biddulphia johnsoniana.
25. Biddulphia tuomeyii.
26. Campylodiscus.
27. Chætoceros.
28. Climacosphenia moniligera.
29. Cocconeis parmula.
30. Cocconeis punctatissima.
31. Cocconeis fimbriata.
32. Cocconeis scutellum.
33. Cocconeis splendida.
34. Cocconeis pseudomarginata.
35. Cocconeis grevillii.
36. Coscinodiscus gigas..
37. Coscinodiscus concavus.
38. Coscinodiscus oculus-iridis.
39. Coscinodiscus subtilis.
40. Coscinodiscus robustus.

41. Cosmoidiscus elegans.
42. Cresswellia rudis.
43. Dictyocha (?) variens.
44. Ditylum.
45. Discoid forms—rare and very plenty.
46. Euodia gibba.
47. Eupodiscus oculatus.
48. Eupodiscus rogersii.
49. Endyctia oceonica.
50. Gephyria constricta.
51. Gephyria gigantea.
52. Gephyria incurvata.
53. Gephyria telfairiæ.
54. Grammatophora marina.
55. Grammatophora—unnamed large variety.
56. Grammatophora macilenta.
57. Grammatophora serpentina.
58. Goniothecum.
59. Glypodiscus stellatus—4, 5, and 9 processes.
60. Hyalodiscus californicus.
61. Hemiaulus californicus.
62. Hercotheca.
63. Heliopelta leeuwenhoekii.
64. Heliopelta nitida.
65. Isthmia nervosa.
66. Melosira sol.
67. Navicula californica.
68. Navicula excavata.
69. Navicula lyra.
70. Navicula nebulosa.
71. Navicula prætexta.
72. Navicula spectabilis.
73. Omphalopelta moronensis.
74. Omphalopelta versicolor.
75. Plagiogramma.
76. Pleurosigma.
77. Podosphenia.
78. Porpeia quadrata.
79. Porpeia ornata.
80. Rhabdonema adriaticum.
81. Raphoneis.
82. Rutilaria epsilon.
83. Rutilaria obesa.
84. Stictodiscus californicus.
85. Stictodiscus hardmanianus.
86. Stictodiscus—new form.
87. Synedra—very large.
88. Stephanopyxis oblongus.
89. Stephanopyxis umbonatus.
90. Surirella.
91. Stauroneis aspera.
92. Triceratium arcticum.
93. Triceratium montereyii.
94. Triceratium parallelum.
95. Triceratium wilkesii.
96. Triceratium—large variety of forms.
97. Triceratium, with five or six angles.
98. Xanthiopyxis—new.
99. Xanthiopyxis oblonga.
100. Xanthiopyxis umbonatus.

50. DOLOMITE. Named from the French geologist Dolomieu. Carbonate of Lime and Magnesia.

When pure it has the following composition:

Carbonate of lime	54.35
Carbonate of magnesia	45.65
	100.0

H=3.5—4, sp. gr. 2.8—2.9; color, white, gray, green, brown, and nearly black. Many limestones contain magnesia, and are classed as magnesian limestones. Dolomite may be distinguished from limestone by the feeble action of cold acids upon it, although when the acid is hot, the effervescence produced is energetic. Dolomite makes better and more durable mortar than ordinary lime, and it is generally an excellent building stone, though some varieties decompose when exposed to the humid, smoky, and sometimes acid atmosphere of large manufacturing cities, like London. Dolomite is rather abundant in California, and is found, according to Blake, at the following localities: Amador County, in narrow snow white veins, traversing a talcose chloritic rock and bearing coarse free gold; Calaveras County, Angel's Camp, in the Winter Hills and other mines, massive, with the quartz veins, and bears gold; sometimes in fine crystals, lining cavities; San Bernardino County, at the Amargosa mine, bearing coarse gold. It is also found with pyrite, at Mumford's Hill, Plumas County (Edman), at Mount Catherine, Napa County, and in Mendocino County.

The following localities are represented in the State Museum: (2175) from the Modoc mine, Inyo County. (2238) resembling fossil coral, Moro, San Luis Obispo County. (2524) in nodules, from a few inches to a foot or more in diameter, some of them containing cavities lined with crystals. (4483) pure white variety, Amargosa wash, San Bernardino County. This rock is very common in the Inyo Range, from the White Mountains, Mono County, southward. White Mountain peak is named from the appearance of its summit which seems to be composed of this rock, often mistaken for snow, and which is found in great quantities at its base. (5051) is a specimen of the same from near Independence, Inyo County. (5558) is the same rock found at Tujunga Cañon, San Gabriel Mountains, Los Angeles County.

51. DUFRENOYSITE. Etym. *Dufrénoy*, French mineralogist.

A mineral composed of sulphur, arsenic, and lead. Said to be found in the Union mine, Cerro Gordo, Inyo County (doubtful).

ELECTRUM—see Gold.

52. EMBOLITE. From a Greek word, meaning an intermediate.

This is a chloro-bromide of silver. Except in being dark green in color, it resembles cerargyrite, and may be distinguished by the tests given under that head. It is rather an abundant mineral in southern California, but is seldom found in masses of any considerable size, being generally disseminated throughout the other ores of silver, or occurring in their crusts. It is almost always associated with cerargyrite, for which it is often mistaken. It is found in the Minnie mine, Sweetwater Range, Mono County, and in the Indiana mine, near Swansea, Inyo County. No. 5025 is a large specimen of silver ore (brecciated), a large portion of which is covered with embolite. It is from the Alhambra mine, Calico district, San Bernardino County.

EMERALD NICKEL—see Zaratite.

53. ENARGITE. Etym. *obvious* (Greek).

This mineral is a sulpho-arsenide of copper, sometimes containing antimony, iron, silver, or zinc. It occurs at least at one place in California, where it is abundant, associated with pyrite and other minerals. It has a disposition to change to arsenious acid and sulphate of copper, a reference to which has been made under the head of arsenolite. The locality is the Morning Star mine, Monitor District, Alpine County, from which there are fine specimens in the State Museum, Nos. 639 and 2832.

54. ENSTATITE. Etym. *An Opponent* (Greek). Bronzite.

This mineral is a silicate of magnesia, alumina, iron, lime, manganese, etc. The variety Bronzite is found in Alameda County. No. 4237 is from the Berkeley Hills.

55. EPIDOTE. Etym. *Increase* (Greek).

Is a silicate of alumina, lime, iron, etc., which occurs sparingly in California, at Long Valley, on the Mohawk road, Plumas County

(Edman), Miners' Ravine, Placer County (Dana). It has been found with copper ores in Calaveras and El Dorado Counties, but the exact localities are uncertain.

Erubescite—see Bornite.

56. EPSOMITE. Epsom Salt, Hair Salt, Sulphate of Magnesia.

$MgO\ SO_3 + 7\ HO$.

Magnesia	16.3
Sulphuric acid	32.5
Water	51.2
	100.0

This rather rare mineral occurs in the Redington quicksilver mine, Napa County, in curved porous crystals several inches long, white color, nearly wholly soluble in water, gives much acid water in closed tube, and a black sublimate of sulphide of mercury which is present as an impurity. B. B. on ch. melts in its water of crystallization, and becomes pink on addition of nitrate of cobalt at a red heat.

A qualitative analysis shows it to contain alumina, and traces of iron. The small residue left after solution in water was examined microscopically and found to consist of black, yellow, and transparent particles, some sulphide of iron (pyrites), and a small amount of cinnabar. The black particles proved to be magnetite, the yellow free sulphur, and the transparent, selenite—altogether an interesting association, and one that will be studied more carefully in the future. This specimen has been entered No. (6001) in the Museum catalogue.

Erubescite—see Bornite.

57. ERYTHRITE. Etym. *Red* (Greek). Arseniate of Cobalt.

This rare mineral has recently been found in California and Nevada. It is found as a rose-red incrustation on a grayish earthy mineral at the Kelsey mine, Compton, Los Angeles County (2805). It was described by Prof. William P. Blake in "Contributions to the Mineralogy of California," in the appendix to the second annual report of the State Mineralogist, 1882, which is repeated here:

Erythrite: Cobalt Bloom. In minute mamillary incrustations, showing when broken, radial aggregations of silky, fibrous crystals. Color: deep carmine or rosy-red, also, peach-blossom red. Streak same color, but blue after the mineral has been heated. It gives the usual reactions for cobalt, arsenic, and water. Occurs also in massive earthy aggregations, of small fibrous crystals, of a rose-pink color. It is associated with an ore of silver and cobalt in dark colored earthy masses, a mechanical mixture, assaying at the rate of 5,000 to 6,000 ounces of silver to the ton, but the precise nature of which is not yet ascertained, in a gangue of heavy spar, containing also nodular masses of chalcopyrite (yellow copper ore). This is believed to be the first observation of the occurrence of this species in the United States.

This mineral, which is valuable, may be easily distinguished by the following reactions: B. B. on ch. gives off arsenic fumes, which smell like garlic; when the fumes cease, the assay powdered in an agate mortar, yields to a bead of borax a beautiful blue color. The mineral is soluble in muriatic acid, giving a rose-colored solution.

Cobalt is a metal named from Cobalus, the demon of miners. The ores were at first considered mysterious and intractable (Ure).

It is reddish gray in color, sp. gr. 7.7, magnetic, slightly malleable, fuses at a lower temperature than iron, but higher than gold. It has no use in the arts, but its oxide is largely employed to color glass, and in porcelain painting, for which purpose it has been used from the earliest times.

Several pigments are prepared from cobalt, one of which is Rinman's Green, to make which a mixed solution of sulphate of cobalt and zinc is prepared, which is precipitated with solution of carbonate of soda. The precipitate is carefully and thoroughly washed with hot water and calcined.

Thenard's Blue, or Cobalt Blue, is prepared by first precipitating nitrate of cobalt with phosphate of potassium. In another vessel alumina is precipitated from alum by carbonate of sodium, and one part of the first by volume is thoroughly mixed with four parts of the second while still moist. The mixture is then dried, calcined, and ground to a fine powder for use.

58. FELDSPAR—see also Albite, Labradorite, and Orthoclase.

The name Feldspar generally applies to *Orthoclase*, but it also indicates a group of minerals, called the feldspar group, as follows: *Albite*—Soda feldspar; *Andesite*—Soda, lime feldspar; *Anorthite*—Lime, soda feldspar; *Hyalophane*—Buryla, potash feldspar; *Labradorite*—Lime, soda feldspar; *Oligoclase*—Soda lime; *Orthoclase*—Potash feldspar.

The feldspars enter largely into the composition of the rocks which form in decomposing soils, and furnish the alkalies so essential to the growth of plants.

The secondary minerals resulting from such disintegration and decomposition are lithomage, kaolin, halloysite, rock soap, agalmatolite, etc.

It is difficult to distinguish the feldspars from each other in rocks, although they may be readily determined if in sufficiently large masses to admit of their being isolated mechanically. This is attempted even in fine-grained rocks, by treating the powdered rock with successive solutions having different specific gravities. The microscope aids the lithologist. One skilled in the use of the instrument, and practiced in observing rocks cut into thin sections, seldom fails in recognizing the species by simple inspection. Lithology has so direct a bearing on mineral veins and their contents that the prospector would do well to study rocks, by collecting them and observing their characteristics and differences. There are several excellent works on this subject, although generally they have the fault of being too scientific for the average mining prospector, and in not giving sufficient detailed instruction in classification and determination.

The following are practical and fairly explicit, and can be recommended to those who desire to study the very useful and fascinating science of Lithology or Petrology:

Rocks classified and described by Bernhard Von Cotta, London, 1866, and "The Study of Rocks," by Frank Rutley, New York, 1879.

Pinkerton's Petrology is a most excellent work, although published in 1800, but it is out of print and difficult to obtain. There are many elaborate and costly works on this subject published within a few years, and since the microscope has been applied to the study of rocks. Any bookseller would send a list of them on application being made to him.

59. FLUORITE. Etym. *To Flow* (Latin). Fluor Spar, Fluoride of Calcium.

Found only sparingly in small white cubes, with copper ore, at Mount Diablo, Contra Costa County (Blake).

FLUOR SPAR—see Fluorite.

FRENCH CHALK—see Talc.

60. GALENA. Etym. *Lead Ore or Lead Dross* (Latin). Galenite—see, also, Lead. Sulphide of Lead. (Pb.S.)

Lead	86.6
Sulphur	13.4
	100.0

Color, lead gray; luster, highly metallic. H=2.5—2.75, sp. gr.= 7.25—7.7, easily fusible. When melted in a crucible with metallic iron, metallic lead and sulphide of iron are produced. B. B. on ch. melts easily, giving off fumes of sulphur; after a continued blowing a button of lead is obtained which generally affords a bead of silver if cupelled. Galena is a common ore of lead and very abundant in California. It is found in the northern part of the State with pyrite and blende, in the gold mines, and in the south with silver ores; sometimes disseminated through the ore, at other times in distinct veins, and in masses of considerable size. The time will come when by a proper system of concentration this mineral will be gathered and will add largely to the lead production of the world. It is found with copper ores in Light's Cañon and in Granite Basin, Plumas County (Edman); in Calaveras County, at Murphy's, in the Star of the West mine, Blue Mountain district, and the Gold Hunter claims (Blake); in Nevada County, with gold in the several gold mines, and at Meadow Lake with blende and gold; in Tehama County at Cow Creek; in Sacramento County at Michigan Bar, with blende and pyrite; in Mariposa County in the Marble Springs mine. Galena is well represented in the State Museum from the following localities: (295) San Bernardino County; (673, 4071) Santa Catalina Island; (1105) New Coso mine, Inyo County; (1302, 4211) argentiferous, Hidalgo mine, Inyo County; (1394, 2112) May Lundy mine, Homer District, Mono County; (1653) Modoc mine, Inyo County; (1880) in quartz, Rising Sun mine, near Aqueduct City, Amador County; (3587) argentiferous, showing radiated structure, Brown Monster mine, Inyo County; (4759) with native silver, partzite, etc., Tower mine, near Benton, Mono County; (5329, 5330, 5331) Soulsby mine, Tuolumne County, in white quartz with heavy gold, pyrite, and blende.

61. GARNET. Etym. *Pomegranate Seeds* (Latin). Andradite.

Garnets are found in a number of localities in California, but no stones suitable for jewelry work, or which could be called gems, are known. According to Blake, garnets are found at the following localities: El Dorado County, at the Fairmount mine, three miles from Pilot Hill, in large blocks and masses two feet thick and more. Associated with specular iron, calc spar, iron pyrites, and copper pyrites, with actinolite in steatite, near Petaluma, Sonoma County. In large semi-crystalline masses, weighing ten to twenty pounds, and of a light color, in the Coso mining district. (Specimens of this were brought to San Francisco under the supposition that it was tin ore.) A beautiful green grossular garnet is found with the copper ore of the Rogers claim, Hope Valley, El Dorado County, and similarly in copper ore at the Mountain Meadows, Los Angeles County. Anderson & Randolph, jewelers of San Francisco, report precious garnet in Calaveras County. Aaron found garnets in clusters near Mono Lake, Mono County. Edman discovered iron garnets in Long Valley, Plumas County. Dana gives the following localities: In copper ore, Mountain Meadows, Los Angeles County; Soledad mine, San Isabel, San Diego County; and chrome garnet near Idria, Fresno County.

Garnets may be seen in the State Museum from the following localities: (243) In mica schist, 30 miles northeast of San José, Santa Clara County; (2365) Peru Mountains, Ventura County.

They also occur in schist at the mouth of Russian River, Sonoma County.

62. GAY-LUSSITE. Etym. *Gay-Lussac*, French chemist.

This is a carbonate of lime and soda found in alkaline lakes in fine crystals. It has no present economic value. Thinolite, which forms mountains in Nevada and elsewhere in the Great Basin, is believed to be a pseudomorph after Gay-Lussite; if this is so, the quantity of carbonate of soda set free must also have been very great. This subject forms the substance of several chapters in the "Geology of the Fortieth Parallel," Clarence King. Gay-Lussite is found in California at Borax Lake, San Bernardino County, and probably elsewhere.

63. GEOCRONITE. Etym. *Earth* and *Saturn*, the alchemistic name for lead (Greek).

Sulphide of lead and antimony, has been observed with galena in small masses in the Inyo Mountains, Inyo County. A specimen was exhibited in the California collection at the Paris Exposition of 1878.

64. GLAUBERITE. Etym. *Glauber*, German chemist.

Sulphate of lime and soda, was found at Borax Lake, Lake County, in blue clay at a depth of 40 feet, having been obtained in an artesian boring (Dana). It is reported also in San Bernardino County, at the borax works, and it is said to exist at the Geysers in Sonoma County.

65. GLAUCOPHANE. Etym. *Glaucus*, sea green color (Latin). Wichtisite.

This mineral occurs in a rock matrix, widely distributed in California, and associated with serpentine. The rock was first observed in 1877, when sections were cut for microscopic observation. A specimen was exhibited at the Paris Exposition of 1878, and when seen by M. Michel Levy was recognized as the "Mica schiste a glaucophane de Syra, Greece," figured in his "Mineralogie micro-graphique des Roches Eruptive Françaises," planche 1, Fig. 2. This rock is represented in the State Museum by No. 4259. The wall rock of the Collier mine, six miles northeast of Murphy's, Calaveras County, and (4720) microscopic slide from near the Wall Street quicksilver mine, Lake County; this is the slide exhibited in Paris.

66. GOLD.

PROPERTIES OF GOLD.

There is probably no metal more generally distributed over the earth's surface than gold, but its physical properties are such that it can only exist in comparatively small quantities within the reach of man. Iron and most other metals have such an affinity for oxygen that they form compounds with that element, becoming oxides, which form secondary compounds with other elements and compounds and become part of the rocks which constitute the earth's crust; gold, and a few other metals, having little or no affinity for oxygen, and for that reason called "noble metals," retain their metallic state and are seldom found otherwise.

The color of pure gold is bright yellow, tinged slightly with red. It has a higher luster than copper, but less than silver, steel, mercury, or platinum. It is softer than silver, and more ductile and malleable than any other metal. When passing from a liquid to a solid state it contracts more than any other metal. The atomic weight of gold is 196.5, hydrogen being taken as unity. It fuses at a temperature of 2016 Fahrenheit. Gold may be distinguished from all other substances by the following simple and characteristic tests: *It is yellow; is not acted on by nitric acid, and it fuses B.B. to a bright bead on charcoal without incrustation.* In sufficiently large pieces, it may be recognized by being *malleable under the hammer, and cutting with a knife without crumbling.*

Gold, when alloyed with other metals, cannot be so easily distinguished, as its associates somewhat modify the reactions. The color of native gold is degraded by metals with which it is alloyed. In some localities it is found pale from admixture with silver, and in others red from the presence of copper.

According to Berthier, the specific gravity of gold is 19.258, which may be increased to 19.376 by hammering. In a melted state it is said to assume a bluish-green color. I have never observed this property of gold. Its tenacity is lessened by hammering or rolling, but it may be restored by subjection to sufficient heat.

Gold leaf is green by transmitted light, but it becomes red when strongly heated. In red gold glass, the metal is said to be in the metallic state. Gold does not oxidize at ordinary temperatures, nor in the hottest furnaces. A slight oxidation takes place when it is exposed in thin leaves to the action of the compound blowpipe, or to a powerful galvanic battery. In a vacuum the electric spark divides it into a very fine powder. Gold is less tenacious than copper, iron, platinum, or silver. A wire of gold only the .078 of an inch in diameter will not break until loaded with a weight of 150 pounds. In cooling after fusion gold forms crystals. Gold is not the most beautiful metal, nor is it the best fitted for all the uses to which it is applied, it being found necessary to alloy it with other metals for certain purposes.

Gold powder or bronze is made by grinding gold leaf in a mortar with honey, extracting the honey with hot water, and drying the powder. It is used in illumination and miniature painting.

Gold is extensively used in the arts. More than 1,000 ounces of pure gold are consumed in Birmingham alone every week, and in the whole of England the weekly consumption of gold leaf is 584 ounces, while for electro-gilding and other uses 10,000 ounces are required annually. Two pottery establishments use $35,000 worth of gold per annum, for gilding porcelain and for making purple and rose colors. Nearly 10,000 ounces of gold are consumed by the Staffordshire potteries annually. Gold has become so plentiful that but few persons are met who do not have this metal about their person, either as coin, jewelry, or timepiece. The amount of gold used and lost in ornament is beyond calculation.

Native gold is usually found in scales, threads, plates, and irregular masses, from a few grains in weight to many pounds. Although generally amorphous, it is frequently found in crystals, which usually assume some modification of the octahedron. Crystals of gold are never found large. Beautiful microscopic octahedral crystals of gold are found in the Ida mine in Inyo County, California, and at the White Bull mine, Linn County, Oregon. Many substances are mistaken for gold. Some varieties of mica resemble it in certain lights, so much as at times to deceive the most experienced eye. Chalcopyrite or copper pyrites, or even iron pyrites, are sometimes mistaken for it; and wulfenite or molybdate of lead, quite common in Nevada and Eastern California, bears a perplexing resemblance to it.

One grain of pure gold is worth $0.0430663; one gramme pure gold is worth $0.6646+; one ounce troy of gold is worth $20.671791; one pound avoirdupois gold is worth $301.46+; one ton (2000 lbs. =29,166.6 oz. troy), $602,927.36; one cubic inch (10.12883 oz. troy), $209.38; one cubic foot (17,579.9808+ oz. troy), 1,205.4898 pounds avoirdupois; value $363,409.85. The standard fineness United States gold coin=900; one cubic inch of standard gold, 9.0989 oz.=$169.28; one cubic foot standard gold=$292,500.00. The average specific gravity of California gold dust, as it would be in a box or bag, was found by the United States Mint to be 9.61. It occupies about twice as much space as when melted into bars. A rectangular box, eight by ten inches and five inches deep, will contain $36,000 in gold coin laid in order, and $27,000 poured in and shaken. A bag six inches by nine inches will hold $5,000 in gold coin with room to tie.

ALLOYS OF GOLD.

Gold alloys readily with most metals, the various compounds having physical properties almost characteristic as distinct elements. This is the case more especially when the metals are combined in chemical equivalents.

The only alloys of gold which find extensive use in the arts, are those of silver and copper; pure gold is too soft and too costly a metal to be suitable for coin, or for manufacturing purposes. It is, therefore, hardened by the addition of other metals.

Jewelers' gold is alloyed to suit the purposes for which it is required. The following are some of the alloys, with the technical names given to them:

Yellow gold, pure gold	1000	Rose copper	----	Silver	----
Red gold, pure gold	750	Rose copper	250	Silver	----
Green gold, pure gold	750	Rose copper	----	Silver	250
Dead leaf, pure gold	700	Rose copper	----	Silver	300
Water green, pure gold	600	Rose copper	----	Silver	400
Blue gold, pure gold	750	Iron	250	Silver	----

White gold contains silver in excess.

Alloys are also made by the jewelers, and the manufactured articles acted on by acids. The surface becomes pure gold, and the composite nature of the alloy is dishonestly concealed. The solution said to be used for this purpose, is a mixture of two parts of nitrate of soda, one part of chloride of sodium, one part of Roman alum, in three or four parts of distilled water. The articles are boiled in this solution until the proper shade or color is obtained, generally fifteen to twenty minutes. They are then taken out, washed and burnished.

The alloys of gold and copper are more fusible than either of the metals alone. Copper gives the alloy the required hardness.

Silver and gold form useful alloys, but are liable to separate if the crucible in which they are melted is allowed to stand without being stirred; the alloy is harder than either of the metals. The hardness is at its maximum when the proportions are two parts of gold to one of silver. Twenty parts of gold becomes visibly whiter when alloyed with one part of silver. This alloy is more fusible than pure gold.

Platinum does not alloy readily with gold. To form this alloy, it is necessary to fuse the metals at a very high heat, or the platinum will only be disseminated through the gold. The alloy has the color of bell metal, or tarnished silver. When the platinum is in the proportion of one sixth, the color of gold is lost. An alloy of equal parts of gold and platinum has the hardness of wrought iron. It is slightly ductile.

Gold and antimony form an alloy, which has a pale, dull color; it is exceedingly brittle. The fracture is ash colored.

Alloys of gold with lead have a color from that of pure gold to white, according to the amount of lead employed. All these alloys are brittle, some as much so as glass; the alloy is brittle, if only a trace of lead is present. Even the fumes of lead are said to give gold an inconvenient brittleness.

In the United States the value of an alloy of gold is always expressed in thousandths. The coin of the United States is nine hundred fine, containing nine hundred parts of pure gold in one thousand parts. The gold is melted with one hundred parts of an alloy of nine tenths of copper and one tenth of silver, thus: Gold, nine hundred; copper, ninety; silver, ten; total, one thousand.

In England the gold in alloys is expressed in carats; the carat is divided into four grains, which are subdivided into quarters and eighths. Pure gold is twenty-four carats fine. The standard of gold in England is twenty-two parts of pure gold to two of copper.

It may sometimes be interesting to know the relation between the fineness of gold and its value in carats. Pure gold (one thousand fine) is said to be twenty-four carats fine; twelve carats would evidently be five hundred fine, or one half gold. The following table will show the relative value:

Carats.	Value.	Carats.	Value.
1	.041667	13	.541667
2	.083334	14	.583333
3	.125001	15	.624555
4	.166667	16	.666667
5	.208333	17	.707333
6	.250000	18	.750000
7	.291666	19	.791666
8	.333333	20	.833333
9	.374999	21	.874999
10	.416667	22	.916666
11	.458630	23	.958333
12	.500000	24	1.000000

The following table gives the properties of the alloys of gold with other metals:

Brittle Alloys and their Colors.		Malleable Alloys and their Colors.	
Cobalt	Dull yellow.	Manganese	Gray.
Nickel	Brass yellow.	Iron	Gray.
Antimony	Pale yellow.	Copper	Yellow.
Zinc	White.	Tin	Pale yellow.
Bismuth	Brass yellow.	Silver	Pale yellow.
Lead	White.	Platinum	White.
Rhodium	Yellow.	Palladium	Gray to white.
Mercury	White.	Iridium	Pale yellow.
		Osmium	Pale yellow.

Gold is not found in nature alloyed in chemical equivalents.

VOLATILITY.

Homberg was the first to notice that gold was volatile at a very high temperature. His experiments were made with a large lens, by the aid of which he readily volatilized gold leaf. If a slip of gold foil, or leaf, is placed between plates of glass, the ends being allowed to project, and a powerful current of electricity passed through it, the gold will disappear, while a purple stain will be left on the glass. This experiment was first made by Franklin.

Advantage is taken of the power of electricity to volatilize gold by spectroscopists, when they desire to examine the spectrum of that metal. Some years ago, in Calaveras County, an old furnace used in roasting pyrites, preparatory to its treatment by chlorination, was torn down, and the arch found to be coated with gold. A specimen is preserved in the Museum of the University of California. This is a proof that gold is volatile at a comparatively low heat.

Some interesting experiments made by Mr. James Napier, assayer of the Mexican Mint, published in the Quarterly Journal of the Chemical Society, London, 1857, also show that gold is volatile at a comparatively low temperature. The same experiment was made a number of years ago at the old mint at San Francisco, when gold was discovered on the roof of that building. The experiments of Mr. Napier show that gold, when alloyed with copper, becomes volatile in proportion to the copper present, and to the degree of heat. In one experiment, gold was melted in a small clay cup, with a cupel inverted over it. On removing the covered cup from the fire the cupel was observed to show the characteristic purple stain of gold. A second experiment gave positive proof of the volatility of the precious metal. Observing fumes rising from a black lead melting pot, he placed a bell glass, wet with distilled water, over the pot, and within a few inches as it was being poured, the exposure only occupied one minute of time; on examining the under surface of the glass very many minute globules were observed. The bell glass was washed with water and again examined. The metallic powder was collected, cupelled, and a globule of gold obtained, weighing 4.25 grains.

In refining platinum by the process of St. Claire de Ville, gold, with other metals, is volatilized by the heat required to melt the platinum. This high heat is produced by the compound or oxyhydrogen blowpipe. In melting the natural platinum alloys the foreign metals, such as copper, lead, iron, silver, and gold, are eliminated, and the platinum brought to a state of great purity, simply by raising the heat to a point at which the foreign metals are volatilized. Gold is seen to escape in fumes of a purple color.

DIVISIBILITY.

Recent investigation leads to the opinion that gold, in a state of extreme division, is omnipresent in the earth's crust. T. Sterry Hunt, in his work, "Chemical and Geological Essays," quotes other authors to show that the sea water on the British coast contains, beside silver, gold in solution, estimated to be about one grain to a ton of water. Mr. J. Cosmo Newbery, Chemist of the Geological Survey of Victoria, Australia, has made some very interesting investigations bearing on the divisibility of gold. He found that the water in certain gold mines contained gold. The timber used to support the mine was carefully assayed, and in nearly every case was found to contain gold. R. Brough Smyth, Chief of the Survey, came to the conclusion that the gold was precipitated from solution.

Mr. Newbery had reason to believe, from examination of specimens, that gold was being deposited in many mines. He thinks, however, that finely divided gold is held in suspension in mine water, but not in solution. A sample of mud deposited from mine water of a mine on Hasler's line of reef, Sandhurst, was examined, by careful washing, and the heavier particles were found to consist of auriferous pyrites and free gold. The particles of gold were large enough to be recognized by the microscope. They were in irregular flattened grains.

Pure gold is the most malleable of metals, and there seems to be no limit to its ductility. A single grain has been drawn into a wire five hundred feet in length. It may be beaten into leaves which are only the 282,000 part of an inch in thickness. Reaumer covered a cylinder of silver with .002778 of its weight of gold. It was drawn into a wire, six feet in length of which weighed one grain. This wire was then rolled until it was the one forty-eighth of an inch wide, which increased its length to seventy-five feet. The coating of gold was so perfect that the microscope failed to detect the color of silver. In the days of Pliny gold was beaten so thin that one ounce was flattened into 750 leaves, four fingers square. It has been calculated that the leaves were three times thicker than ours. Gold has been beaten so thin in modern times that 367,000 leaves would only make an inch in thickness, if piled upon each other. The same number of leaves of ordinary printing paper would make a pile seventy-five feet high. Compared with the thickness of the gold on fine gilded wire, gold leaf is thick. It has been calculated that it would take 14,000,000 films, such as sometimes put on the fine wire of which gold lace is made, to equal an inch in thickness, while the same number of leaves of printing paper would make a pile 3,000 feet high. One ounce of pure gold is supposed to be sufficient to gild such a wire 1,300 miles in length.

PLACER GOLD.

When perfectly clean gold is exposed to the action of pure quicksilver, it is instantly seized by the latter and coated with amalgam. The accident of gold being alloyed with other metals in nature does not impair its affinity for mercury, if the surface is made bright mechanically by filing or scraping. Much of the native gold found in placer mines, apparently clean, is slightly tarnished by the oxidizing or mineralizing of its alloy, in which case it amalgamates with difficulty. I have failed in every instance to find gold in quartz in this condition, although intelligent miners have informed me that they have sometimes observed it in their experience. A large proportion of the placer gold found in California is wholly or partly coated with silica, cemented by sesquioxide of iron. When wholly coated it is perfectly inert to the action of mercury (one might as well put gold in a glass bottle and attempt to amalgamate it from the outside). When partly coated, the exposed parts become amalgamated, and to that extent only is the gold held by the mercury. If rusty gold is digested in hydrochloric acid the iron is dissolved, and a slight mechanical force then serves to detach the silica, when amalgamation takes place without difficulty. There is no hope of being able to free the gold from this coating during the few hours it is exposed to the forces employed in the well known hydraulic process. When clean gold amalgamates it does not become homogeneous, but the amalgam forms only on the surface. I have had a piece of placer gold in mercury, standing in my laboratory, for several months, during which time I have frequently triturated it—sometimes several times a day—and it is not yet dissolved; still, in pouring from one vessel to another, the mercury flows freely without showing the gold, but I can at any time fish it up with my finger. Gold so amalgamated could not, in the process of placer washing, escape from the mercury, but coated gold, under the same circumstances, will float on the surface of the quicksilver, and any slight force sufficient to overcome its specific gravity will detach it.

The coating of gold may be imitated, as found by experiment. A piece of pure gold, after annealing, was placed in pure mercury, and it instantly became amalgamated. Another portion, exactly similar, was hammered on a perfectly clean and polished anvil, with a polished hammer, and placed in mercury like the first. It became as quickly amalgamated. Pure quartz was then ground to a powder and sifted on the anvil in a thin stratum. A third piece of the same gold was then laid on the powdered quartz, struck several times with the hammer, turned over, placed on a different spot, and again hammered. The gold was then examined under the microscope, and seen to resemble the coated gold found in the placers, the quartz particles being imbedded in its surface. When placed in mercury, and allowed to remain for some time with frequent agitation, it floated on the surface, and seemed to be wholly unacted upon, but when placed under the microscope it was found that the mercury had attacked the gold through the small interstices, but only to a very limited extent. The gold was then placed on an iron slab, and gently rubbed with an iron muller, by which treatment it became more perfectly coated, and was now an exact imitation of the natural coated gold, minus the iron cement. In the natural coating of placer gold I consider the cementing to be a secondary process, and the sesquioxide of iron to result from decomposing pyrite, which was abundant in the quartz veins that yielded the gold.

Mr. Goodyear thinks, and with good reason, that vast quantities of gold lie under the great valleys of the State, between the Coast Range and the Sierra, which can never be recovered. It has been pretty generally established that the most productive portion of known quartz ledges lie comparatively near the surface; this being admitted, there is reason to believe that if the bedrocks below the present workings should become in time disintegrated, a smaller portion of gold would be set free.

CHEMISTRY OF GOLD.

Ter-oxide of gold is a dark-colored powder, and its hydrate the same color, but of a lighter shade; both are reduced to metallic gold by the action of light and heat. Oxide of gold dissolves in hydrochloric acid, and partially, in sulphuric and nitric acids. All the salts of gold are yellow, and retain this characteristic color even when largely diluted. The salts are decomposed when heated—they have the property of reddening litmus paper even when free from other acids. Hydro-sulphuric acid precipitates all the gold from neutral or acid solutions. This precipitate is ter-sulphide of gold. The precipitate does not yield to any single acid, but dissolves readily in nitro-muriatic acid, and in the sulphides of the alkalies. Sulphide of ammonium also throws down gold from solution, as the ter-sulphide, which redissolves wholly in excess of the reagent, when an excess of sulphur is present.

Proto-sulphate of iron precipitates gold from solutions in the state of finely divided metallic gold powder, at first black, but which becomes gold color and metallic when dried and heated to redness. Gold so treated is chemically pure.

Ter-oxide of gold has the properties of an acid, and is called "auric acid." It may be prepared by digesting a solution of ter-chloride of gold with magnesia, washing the precipitate with water, and dissolving out the excess of magnesia with diluted nitric acid.

Hydrated-ter-oxide of gold forms salts with the alkalies, which are called by chemists "aurates." If finely divided gold be heated with sulphur in the presence of carbonate of potassium, a double sulphide of gold and potassium is formed, which is used in gilding porcelain. If highly concentrated sulphuric ether be added to an aqueous solution of ter-chloride of gold, the chloride will leave the water and take to the ether, which may be separated by decantation. This ethereal solution is used in gilding.

Metallic gold is insoluble in nitric, sulphuric, or hydrochloric acids, but dissolves in fluids evolving or containing chlorine. Nitro-hydrochloric acid is the usual solvent. The solution contains ter-chloride of gold. "Aqua regia," so called by the alchemists because gold (the king of the metals) was conquered by it, is a mechanical mixture of nitric and muriatic acids, generally in the proportion of one of the former to three or four of the latter. Gold is used as a reagent in analytical chemistry as a test for nitric acid—the substance to be tested being boiled with the muriatic acid and the gold leaf added. If nitric acid is present the gold will be dissolved.

Proto-chloride of tin in solution, mixed with ter-chloride of gold also in solution, throws down, even if the solutions are dilute, a purple precipitate with a violet shade. This is one of the most delicate and characteristic tests for both gold and tin. If the solutions are too dilute to give a precipitate, the violet color is still imparted to them. The precipitate is called Purple of Cassius, from a Dutch chemist, who lived at Leiden in the seventeenth century. Purple of Cassius may also be made by forming an alloy of gold, tin, and silver, and dissolving out the silver with nitric acid. To be able to do this, the latter metal must be in considerable excess. Gold Purple is used as a pigment. The composition of the precipitate is not well understood by chemists, but is regarded as a compound of binoxide of tin and protoxide of gold, mixed with protoxide and binoxide of tin and water. Ter-chloride of gold is prepared by dissolving gold—which may contain silver or copper—in aqua regia, evaporating to remove excess of acid, diluting again if necessary; filtering to remove chloride of silver, acidulating with muriatic acid, and precipitating the gold with solution of protosulphate of iron. The precipitate must be washed on a filter with distilled water, dried, redissolved in aqua regia, and evaporated on a water bath to crystallization. Chloride of gold is obtained by evaporating a solution of ter-chloride of gold to dryness, heating the powder on a sand bath at the temperature of melting tin, and stirring as long as chlorine is evolved.

Ammonia precipitates from concentrated solutions of gold an orange colored precipitate of aurate of ammonia called also "fulminating gold." It is a very dangerous substance—it can be dried at 212° F.—but the slightest friction causes it to explode with the greatest violence. A dreadful accident happened in the laboratory of Beaume—an assistant lost both of his eyes by the explosion of a vial of fulminating gold, caused by the friction of the glass stopper.

Gold may be separated from alloys of other metals, with the exception of tin, antimony, and platinum, by simply boiling with nitric acid, but the gold must not be present in a larger proportion than one fourth. Should the proportion be greater, silver or copper must be melted with the alloy, which must be granulated by pouring, while in a fluid state, into water. Upon being boiled in concentrated nitric acid, the other metals will be dissolved, leaving the gold as a metallic powder. Gold is also separated from alloys by means of strong sulphuric acid. The alloy is granulated, as above, and treated in a suitable vessel of platinum or cast iron. Two and a half parts, by weight, of 66° acid is added, and heat continued as long as sulphurous acid is evolved. By this treatment silver and copper become soluble sulphates, while the gold remains unchanged. The solution is poured off, and the gold again boiled with a fresh portion of acid, of 58° Beaume, and the whole allowed to remain for a time at rest. The gold settles from the solution, after which silver is precipitated by plates of copper, the copper replacing the silver, which, with the copper in the alloy, is crystallized out as sulphate of copper, or precipitated, as metallic copper, by plates of metallic iron. The gold still contains a small portion of silver, which is separated by a second boiling with strong sulphuric acid, after which it contains only .005 per cent. This process is not suitable for alloys containing more than twenty per cent of gold. If richer, the alloys must be remelted, with the addition of sufficient silver to reduce them to this standard.

ELECTRUM—NATURAL ALLOY OF GOLD AND SILVER.

It is a well known fact that the gold in California is argentiferous. Formerly the average fineness was 885, but it is not now so high. The record of the assay of several millions of dollars worth of California gold at the Philadelphia Mint showed an average of 880, the sample lots having a range between 870 and 890.

There is a region of country, lying partly in California and partly in Nevada, in which the gold contains an unusually large quantity of silver. At Aurora, in Esmeralda County, Nevada, the gold is of this nature. During several years' mining in that locality, no true silver minerals, that could be distinguished as such, have been noticed. A blue stain in the rock has, we think, never been examined microscopically or chemically. Most of the rich rock was "peppered" with pale gold, and most of the bullion came from this source.

Many years ago, a specimen of white quartz from the Jeff. Davis mine, situated near Millerton, in Fresno County, was exhibited, in which a quantity of very pale native gold was imbedded.

The Bodie electrum is of a pale yellow color, resembling German silver; has a metallic luster; takes a high polish; is malleable and ductile; its hardness equals 3; it is softer than either a gold or silver American coin, being scratched by both.

Specific gravity, 15.15; contains gold, 633.4; silver, 364.1; total, 997.5.

Electrum is well known to mineralogists, although it is rather rare. The largest mass of which we can find any record was taken from the mines of Vöröspatak, in Transylvania; it weighed twenty-five pounds, and contained twenty-five per cent of silver.

Electrum was also well known to the ancients. Pliny, in his great work on Natural History (book 33, chapter 23), describes it as containing silver in varying proportions. "When the silver is one fifth of the ore, it is known as electrum." He also mentions an artificial electrum made by melting together gold and silver. In writing of the properties of electrum, this ancient writer states "that one peculiar advantage of electrum is its superior brilliancy to silver by lamplight." The reader, however, begins to lose confidence in his judgment when he states seriously that native electrum has the property of detecting poisons; "for, in such a case, semicircles will form on the surface of the goblet, and emit a crackling noise like that of a flame, thus giving a twofold indication of the presence of poison."

Electrum is known from California to Cape Horn, among miners of Spanish descent, as "*oroche*," which fact would indicate that this mineral is not uncommon on the American Continent. The gold of Chili ranges in fineness from 840 to 960.

The following analyses of electrum are from Dana's Mineralogy:

	Gold.	Silver.
Barbara Transylvania	645.2	354.8
Vöröspatak Transylvania	604.9	387.4
Siranovski Altai	609.8	383.8
Schlangenberg Altai	640.0	360.0
Santa Rosa, New Granada	649.3	350.7

There seems to be a law governing the fineness of native gold in countries where mines of silver exist, and it may be reasonably expected that in localities where the gold is found to be argentiferous, silver mines may be discovered, if not already known.

GEOLOGY.

Experience has shown that the soil of gold countries contains particles of gold which may be separated by washing. Beds of streams contain more gold after they enter the plains than before. Gold is found in certain localities in streams. In following them upward toward the mountains it is frequently found that the gold disappears. Many rivers afford no gold while they run in the hills, but it is found on bars below. Gold and iron are found associated in all localities, and it is a question if all pyrites will not afford at least a trace of gold with the same certainty that all lead contains more or less silver.

There is a remarkable instance at a mine in El Dorado County, California, in which small globules of gold are found on the surface of large crystals of pyrite. The gold seems to have been squeezed out of the crystals. Fine specimens of this singular association of minerals may be seen in the State Museum. Humboldt has stated that in Guiana gold, like tin, is sometimes disseminated in an almost imperceptible manner in the granite rocks, without the ramification or interlacing of any small veins. At the Braidwood district, south of Sydney, New South Wales, there exists a variety of feldspathic granite, described by the Rev. Mr. Clarke as being permeated by small particles of gold; and Murchison has quoted a statement by Hoffman, that in Siberia gold is found in minute quantities disseminated through clay slate.

Every variety of placer mining is based upon the fact that gold has a greater specific gravity than most other metals or substances. This property causes it to resist the force of water in motion, which, acting upon other lighter minerals, moves them forward in the direction of the course of the stream, while the gold remains behind, and taking advantage of the agitation of movable particles, caused by the action of the water, gravitates toward the earth's center until arrested by the fixed rock formation, technically known to the miners as "bedrock." It frequently happens that the bedrock of a mountain torrent upon which the gold settles is smooth, and having a descent toward the plains below, the gold is forced forward by the stream, aided by the moving bowlders, until it meets some accidental depression, where it remains. Similar conditions cause other gold particles to move to the same depression, where in time a considerable quantity collects, and a natural placer is formed. In the early history of California such depressions were sought in the beds of modern rivers, and large quantities of gold taken out. When the laws which govern these deposits were still but vaguely understood, the miner could without difficulty pan out almost fabulous quantities of gold dust. These placers were successively discovered and exhausted, after which gold washing became more and more difficult, and costly operations were then undertaken. Beds of swift-running rivers were exposed by turning the waters aside in artificial channels or flumes. Soon other appliances were required and invented to facilitate the collection of the gold from the placers, the cream of which had been skimmed by the lucky ones first on the ground.

Gold has been observed native in the following minerals and rocks: Pyrite, chalcopyrite, galena, sphalerite, mispickel, tetradymite, native bismuth, stibnite, magnetite, hornstone, asbestus, tellurium, orpiment, hematite, barite, fluorite, siderite, chrysocolla, cuprite, granite, porphyry, and quartz. In California it is found at Moccasin Creek, Tuolumne County, in steatite; in the Manzanita mine, Sulphur Creek, Colusa County, in cinnabar; in Mono County in calcite; in the Melones mine, Tuolumne County, in sylvanite; in roscoelite at several localities near Coloma, El Dorado County; in galena, near Walker River; in pyrolusite at the Banghart mine, Shasta County; in chalcedony in the Empire mine, Grass Valley, Nevada County, and in asbestus near Georgetown, El Dorado County.

Dr. Percy thinks that gold is precipitated from an aqueous solution. Murchison holds that quartz is of volcanic or solfataric origin, and has all been in a gelatinous state, in which it included the gold mechanically. He gives as an example, the silicious sinter which rises in a fluid state from Hecla, and coagulates into quartz around the volcanic vents. The oldest rocks are the most likely to contain gold in place, viz.: the azoic and the palæozoic. The general facts relating to the geological occurrence of gold are similar, without regard to geographical position.

Sir Roderick Murchison has assumed that gold cannot be expected in considerable quantities above the palæozoic rocks. It has been observed by other geologists that in California gold is found in abundance in the jurassic and cretaceous formations. These more recent rocks are made up of the older ones, changed by the action of nature's laws, and gold being metallic and free, has gravitated to the position in which it is now found. The great mother vein, which is probably the source of all the gold in California, is so metamorphic in character that its geological age is still unknown; but there are evidences that it is much older than the formation in which gold is found. Had there been no eruptive rocks, gold would probably have been unknown to man.

TESTING AND ASSAYING GOLD AND ORES AND MINERALS CONTAINING IT.—GOLD WASHING IN MINER'S PAN.

The miner's pan is made of the best quality of Russia iron, some are stamped out of a single sheet, while others are jointed like the sections of a stovepipe; no solder is used as it would soon be taken up by the quicksilver frequently used. The miner's pan is, in form, something like the common milk pan, but with the sides more flaring. The usual dimensions are ten inches in diameter at the bottom, sixteen inches at the top, and two and two tenths inches deep. The angle of the sides from the horizontal is thirty-seven degrees. The rim is strengthened by a strong iron wire rolled in. This is the conventional miner's pan, and is the result of thirty-three years' experience in California. The retail price of such a pan, in San Francisco, is ninety cents.

The mode of using the pan, in placer mining, is as follows: Having carefully removed the superficial earth to a point within a few inches of the bedrock, the miner places a portion of the gravelly matter containing gold, in his pan, and goes to a neighboring stream, or pond, and kneeling by the side of the water, sinks the pan containing the auriferous earth slowly beneath the surface, holding it horizontally, and causing the water to flow into the pan equally over the sides; when the pan is full, he lifts it and placing it on his knee or on a convenient stone, he stirs the mass with his fingers.

The skillful miner, in washing a panful of "dirt," unconsciously divides the operation into five stages. He breaks the lumps with his fingers and stirs the contents of the pan until a soft mud is formed. Sinking, now, the pan beneath the water, the second stage commences. This is to so agitate the muddy prospect that gold, gravel, and coarse sand sink to the bottom, while the finer and lighter particles flow over the rim and escape. This being for a time continued, the remaining contents of the pan become clean and the water is no longer loaded with slickens. The third operation is to pick out carefully all the large pebbles and gravel, which are examined, and if found worthless, are thrown aside. The agitation is continued with but little water in the pan, and by a motion of the ball of the thumb, difficult to describe, the coarse particles are raked out and rejected. At this stage a very large proportion of the original prospect has been removed, but every grain of gold lies at the bottom, although still invisible. The fourth operation is to so agitate the remaining contents of the pan (now inclined and only partly under the water) that the coarse sand flows over the edge in a thin stream, every particle passing under the eye of the operator, who may be certain that no gold escapes. This is continued until but a small quantity remains in the pan, when, lifting it from the water, the last operation begins, which is the concentration and perfect separation of the gold. This is effected by an undulatory motion, causing the sand to flow with the water across the bottom of the pan, revealing a cluster of gold particles, if the dirt is rich and wholly isolated. The pan is then inclined toward the sand, leaving the gold stranded in one portion, and the sand and water lying in another. The edge containing the sand is then held over and very near the water, of which the miner lifts a small quantity in the hollow of his hand, and pouring it behind the sand, washes it away, leaving the gold only in the pan. There being no quicksilver used, the gold is collected wholly by its specific gravity.

It usually is found that a small portion of black sand appears beneath the lighter colored residue which results from the disintegration of igneous rocks, which does not necessarily indicate the presence of gold, although if gold is found at all it is generally associated with black sand, as they possess similar specific gravities. The gold may be dried in the pan and brushed out into some convenient receptacle. The last portion of black sand is taken out with a magnet, and the quartz sand gently blown away while the gold lies on a clean piece of paper, or in a peculiar flat scoop of tin plate or brass, made for that purpose.

From this "prospect" the gold washer judges of the value of the claim. Each particle of gold, no matter how small, is called a "color." To find the color is to find at least one particle of gold. From the quantity he will estimate, in a rough way, the value of the gold. He will state, with considerable accuracy, that there are "five cents to the pan," or "one dollar to the pan," as the case may be. Sometimes a large piece of gold will be found; but such a circumstance is quite unusual. The gold washer's pan, in the last stages of the operation described, often contains substances of great interest to the mineralogist; as, for example, beautiful zircons, platinum, unique crystals or scales of gold, occasionally rubies, and even diamonds, too minute, however, to have any but a scientific value, rolled masses of chromic iron, etc.

The miner's pan has become, in California, a sort of *vade mecum*, not only to the miner, but to the millman and the assayer. The same results are obtained in other countries by different appliances. The Cornish miner tests the quality of his tin ores by washing on the blade of a shovel; the Mexican uses a horn spoon, and the Brazilian the batea.

HORN SPOON.

The horn spoon is a long irregular trough cut from a large ox horn. It is divided from the horn by sawing; when first cut is rough and clumsy, but by scraping it is soon reduced to an elegant and convenient vessel, admirably suited for washing small quantities, but too small for utility in placer mining, and open to the objection that it soon warps out of shape, and under the influence of repeated wetting and drying, cracks and becomes worthless. While the horn spoon is inferior to the miner's pan, the Brazilian batea is superior, and should be better understood by miners generally.

BATEA.

The batea is a wooden bowl used in the place of the miner's iron pan, which is a convenient modification of it; but while the iron pan is generally useful, the work done by the batea is better. The Brazilian batea is a rude vessel of wood, but the improved California batea is constructed on scientific principles, and is the invention of Mr. Melville Attwood, of San Francisco, who is remarkably skillful in its use. The following is his description:

Batea is the name given to the gold-washer's bowl, or vanning dish, used in the placer and gold mines of Brazil; a small implement, which affords the most simple method of separating, on a limited scale, the grains of gold from the dirt, sand, pyritic matter, magnetic iron, etc. The form of the batea in common use in Brazil is a circular, shallow, wooden dish, or bowl, rudely fashioned with an adze and chisel, varying considerably in depth and size, but, nevertheless, in practical hands giving remarkable results.

In 1853 I had a few bateas made of a much better form, the inside being turned smooth to the center, in a lathe. I introduced them at that time into the mills under my control at Grass Valley and Agua Fria, where they were used for the purpose of testing or making mechanical assays of the tailings, blanket-washings, and as a concentration to find the percentage of pyritic matter in the vein-stone under treatment.

Some years ago numerous samples of sea beach, or gold sands, were sent to me for examination, and as the batea I had then in use did not separate the gold particles as clean and rapidly as I wished, induced me to make further alterations. After many trials and much trouble, I succeeded in getting the form I now use. Those persons accustomed to use the horn spoon, or pan, would be astonished at the ease and rapidity with which the gold in the sands can be washed out with this improved form of batea. As a concentrator for small parcels, or to test the working of a larger one, nothing that I have yet seen in operation can equal it.

The form of the California batea is such that the sands on the bottom form a perfect sector, the gold, cinnabar, tin ore, galena, or other heavy minerals, lying on the point in the most perfect state of concentration. No matter how small the quantity, it is wholly isolated, and may be observed with a magnifying glass if required.

Mr. John Roach, optician of San Francisco, gives the following directions, by which, he says, any good turner will be able to make them: "A disk of seventeen inches diameter being turned conical twelve degrees, will have a depth of one and seven eighths inches from center to surface. The thickness may be five eighths of an inch. The other edge, perpendicular to axis, will require wood two and one half inches thick for its construction. The best wood is Honduras mahogany."

To millmen it is a most useful implement, enabling them, amongst other things, to test what quicksilver is being carried away in the tailings. Silver ore can easily be separated from its gangues. The lithologist it will help greatly in his examination of the rocks.

The movements of most of the large concentrators can be easily copied, particularly that of the percussion table, but with the difference in favor of the batea, that the shock, either light or hard, can be given and varied as required, by striking the side of the bowl with the hand.

The manner of using the batea may be described as follows: Quite a quantity of water will be required. This may be contained in a tank or large tub, or the operation may be conducted at a convenient place near the bank of a stream or lake. The pulverized ore—several pounds at a time—is placed in the batea, which is gradually sunk in the water. Several times it is broken down with the fingers, while the batea floats on the water. When the ore is thoroughly wet and formed into mud, the batea is taken by the rim with both hands and again sunk in the water. A circular motion is then imparted to it (soon learned by practice). The lighter particles will continuously flow over the edge and sink, while the heavier ones collect at the center.

When only a small portion remains, the batea may be lifted, and the water held in the depression caused to sweep round the center, while one edge is slightly depressed. This motion will gradually remove the heavier particles toward the depressed part. If there is any gold, platinum, galena, cinnabar, or other unusually heavy substance, its gravity will resist the power of the water, while comparatively light particles move slowly forward. The form of the vessel is such that the heaviest matter can be closely observed. If there is a particle of gold present, it will be found at the point, clearly distinct from all other substances. The value of the batea to the prospector cannot be too highly estimated, and it should come into more general use.

Applications for the improved batea have been made to the State Mining Bureau from Australia, where it is to be introduced.

MECHANICAL ASSAY OF SANDS CONTAINING GOLD, CRUSHED QUARTZ, OR OTHER ORE CONTAINING FREE GOLD—BASED UPON COMMON PAN-WASHING OR PROSPECTING.

As this assay is of the utmost practical value to the miner, I shall describe it with minuteness.

It must be understood that this is only a working test. It does not give all the gold in the rock, as shown by a careful fire assay, but what is of equal importance to the mine owner, millman, and practical miner, it gives what he can reasonably expect to save in a good quartz mill. It is really milling on a small scale. It is generally very correct and reliable, if a quantity of material be sampled. The only operation which requires much skill is the washing, generally well understood by those who are most likely to avail themselves of this instruction. These rules apply equally to placer gravels. Take a quantity of the ore—the larger the better—and spall it into pieces of less size than an egg. If more than 500 pounds spread on a good floor and, with a shovel, mix very thoroughly; then shovel into three piles, placing one shovelful upon each in succession, until all is disposed of. Two of the piles may then be put into bags. The remaining pile is spread out on the floor, mixed as before, and shoveled in the same manner into three piles. This is repeated according to the quantity sampled, until the last pile does not contain more than thirty pounds of ore. As the quantity on the floor becomes smaller, the lumps must be broken finer until the last, when they should not exceed an inch in diameter. What remains is removed to an iron slab and, by the aid of an iron ring and hammer, reduced to the size of peas. The whole thirty pounds is then spread out, and after careful mixing, portions are lifted with a flat knife—taking up the fine dust with the larger fragments—until about ten pounds have been gathered. This quantity is then ground down fine with an iron muller, and passed through a forty-mesh sieve. If the rock is rich, the last portion may be found to contain some free gold in flattened discs, which will not pass the sieve. These must be placed with the pulverized ore, and the whole thoroughly mixed, if the quantity is small; but if large, must be treated separately, and the amount of gold calculated into the whole ten pounds, and noted when the final calculation is made.

From the thoroughly mixed sample two kilogrammes (two thousand grammes) must be carefully weighed out. This is placed in a pan, or, better, in a batea, and carefully washed down until the gold begins to appear. Clean water is then used, and when the pan and the small residue are clean, most of the water is poured off and a globule of pure quicksilver (which must be free from gold) is dropped in—a piece of cyanide of potassium is also placed with it. As the cyanide begins to dissolve, a rotary motion is imparted to the dish—best done by holding the arms stiff and moving the body. As the mercury rolls over and plows through the sand, under the influence of the cyanide, it will collect together all the particles of free gold. When it is certain that all is collected, the mercury may be carefully transferred to a small porcelain cup, or test tube, and boiled with strong nitric acid, which must be pure. When the mercury is all dissolved, the acid is poured off, more nitric acid applied cold, and rejected, and the gold then washed with distilled water and dried.

The object of washing with acid the second time is to remove any nitrate of mercury which might remain with the gold, and which is immediately precipitated if water is first used.

The resulting gold is not pure, but has the composition of the natural alloy. Before accurate value calculations can be made it will be necessary to render the gold pure and weigh it carefully.

To purify the gold, it must be melted with silver, rolled out, or hammered thin, boiled twice with nitric acid, washed, dried, and heated to redness. The manner of doing this will be described hereafter.

The method of calculating this assay is very simple. It will be observed that two thousand grammes were weighed out. Let the two thousand grammes represent a ton of two thousand pounds, then each gramme will be equivalent to a pound avoirdupois, or one two-thousandth part of the whole, and the decimals of a gramme the decimals of a pound. Suppose the ore yielded, by the assay just described, fine gold, weighing .072 grammes, it must be quite evident that a ton of the ore would yield the same decimal of a pound. Now, as a pound of gold is worth $301 46, it is only necessary to multiply this value by the weight of gold obtained in grammes and decimals to find the value of the gold in a ton of ore—$301 46×.072=$21 70.

Care must be taken in this assay to keep the cyanide solution rather weak, as gold is somewhat soluble in strong solution of cyanide of potassium, and to remember that cyanide is deadly poison, which should be handled with great care.

The crucible assay of ores containing gold, which is the same for *silver*, will be described under that head.

BLOWPIPE ASSAY OF GOLD DUST OR GOLD BULLION.

A person skilled in the use of the blowpipe, possessing a good balance, can make perfectly accurate assays of bullion or gold dust, but the results will only approximate, unless the whole lot is melted into a bar; as this, however, is not always convenient, the following plan may be adopted:

Pour the gold dust out on a large and perfectly clean sheet of paper, and with the ends of the fingers, mix it thoroughly, occasionally lifting the edge of the paper to throw it together, and again mixing to insure uniformity; then, from various parts, lift small portions, until more than an ounce is collected—this is best done with a flat knife, or by pinching with the thumb and forefinger—from this, weigh out accurately, an ounce troy; place this in a small crucible, add a little borax, carbonate of soda, and nitrate of potash, and melt the whole together—this may easily be done in a blacksmith's forge or in a coal stove—when perfectly melted, set the crucible aside, and when cold, break and remove the gold button; this must be freed from clay and slag by light blows of the hammer on its edges, and subsequent washing. When perfectly clean and dry, weigh again. The loss is water, iron, sand, mercury, and other impurities which may be assumed to be the average of the entire lot. Cut off a small portion from each side with a cold-chisel, wrap the pieces in paper to prevent them from flying, and hammer down on the anvil until thin enough to cut with scissors; place upon charcoal and heat with the blowpipe flame until the paper is burned away, taking care not to melt the gold. Cut with a pair of shears sufficient to weigh exactly the tenth of a gramme, or one hundred milligrammes; a portion should be taken from each of the pieces. The weighing must be conducted with the greatest accuracy, for the success of the assay depends upon precise manipulation.

Blowpipe cupels are made of the finest washed bone ash, formed in a cupel mold of boxwood or ebony, hammered with sufficient force to make them compact, and well dried. They are about half an inch in diameter, and less than that in height. For convenience, they may be supported in a ring of platinum wire, in a handle of cork, or fused into a glass rod, as described in works on the blowpipe.

The assay is continued as follows: Place the assay in the center of a piece of lead foil about half an inch square; fold the lead over the gold, and with the fingers carefully form it into a ball and set it aside. Prepare two assays like this. Take the cupel support in the left hand, and, having lighted a spirit lamp, lift one of the cupels by placing the end of the forefinger in the concave part, and holding it lightly with the thumb, place it in the loop of wire. Heat the cupel by urging the whole of the flame upon it, producing, in doing so, a roaring sound. This is best done by holding the point of the blowpipe outside the flame. When the cupel is hot enough, which is known by its becoming white after first blackening, lift with the pliers one of the assays and place it in the center of the cupel. A steadily-pointed blue flame must then be directed upon the assay until it melts and begins to oxidize, when the flame is changed to a roaring blast, and the cupel moved further from the lamp. Cupellation goes on rapidly if the flame is directed against the cupel beyond the assay, and not directly upon it, and if the cupel is kept cool—that is to say, at the lowest temperature at which the lead can be kept fluid. It will be found advantageous to discontinue the flame for an instant occasionally, and to direct it by short puffs at times. The exact point can only be attained by removing the cupel from the lamp, and returning it gradually, as may be required. As the cupellation goes on, the bead becomes more spherical; little patches of lead oxide form and pass to the cupel, becoming thinner, until at last the gold bead can be seen through the slight film of oxide. When nearly finished, the molten gold spits up towards the flame. At last, at the proper moment, learned only by practice, an instant cessation of the blast causes a flash and a bright yellow golden bead remains on the cupel. When cold, the bead is removed from the cupel with pliers, and placed flat side down on a clean piece of paper. It is then grasped with a large pair of pinchers and squeezed by a strong pressure. This generally removes all adhering bone ash, and renders the button fit for weighing. To make sure, turn it over, examine with the magnifying glass, and brush with a small short-bristle brush. If anything should be found attached to it, a squeeze at right angles with the first will generally remove it. Place the button in the pan of the balance and weigh it carefully. Its weight in milligrammes is the total fineness in hundredths. For instance, seventy-four milligrammes would be 740 fine. With a delicate balance, thousandths can be weighed, each tenth of a milligramme being .001.

The button will probably contain silver. To ascertain the fineness of gold it must be subjected to a second process. The weight of the bead being noted, a cavity is made in a piece of charcoal, held by means of a proper support. In the cavity is placed the gold button, with four or five times its volume of pure silver, and both metals are melted together, before a strong blowpipe flame. The alloy must be thoroughly fused. When cool it is wrapped in paper, hammered flat, heated red hot, to burn away the paper, cleaned with a stiff brush, placed in a test tube with nitric acid, and boiled over a spirit lamp until no more red fumes are given off. A black powder, which is gold, will remain. The tube is then filled up with distilled water, which is poured off carefully, so as not to permit any of the finely divided gold to pass away with it. This must be repeated, and the tube filled full for a third time with distilled water. A porcelain cup is then placed over the tube, like a cap, and both inverted together. The gold falls to the bottom of the cup, and the tube is carefully removed. The water is then poured from the gold in the cup, which is first subjected to a gentle heat, and then made red hot by the aid of the blowpipe. During the process the cup may be held, by the aid of pinchers, over the flame of the spirit lamp, which is urged upwards against it from below. When the gold has assumed its metallic color the operation is finished. When cold, the gold is brushed into the pan of the balance, and its weight, in tenths of a milligramme, noted. The results may be written as follows: Suppose the weight of the cupelled button, in milligrammes, to be 74.4, the total fineness will be 744; weight of gold powder, 69.2=692; fineness of silver, 52. Or, fineness of gold, 692; fineness of silver, 52; total fineness, 744.

It is important in estimating the value of purchased gold dust, to carefully examine, to see if there is any counterfeit, or, as it is called, "bogus" dust present. If all from the same locality, the dust will have a uniform color. Any suspicious looking pieces should be set aside and cut with a cold-chisel while lying on a small anvil. A fair sample of the whole lot of gold dust under examination should then be placed in an evaporating dish, the suspected pieces being placed on top, and nitric acid poured over them. If any reaction takes place, such as effervescence or evolution of red fumes, or if the acid becomes colored, there is foreign matter present, and should this be the case, adulteration or counterfeit gold dust may be suspected.

Place two watch glasses, one on a piece of white paper and the other on black, or other dark color; then, with a glass rod, convey a few drops of the acid from the dish to each. To the white, add a drop or two of ammonia, until it smells strongly ammoniacal; a blue color indicates copper. To the other add hydrochloric acid in the same manner. If a white curdy precipitate forms, which does not dissolve upon the addition of water, silver is being dissolved from the gold dust in the evaporating dish. If the dust is of very low grade, these metals may dissolve in very small quantities. But such gold dust would be easily detected by its inferior color and appearance.

If no action is observed, even after heating the dish, there is no counterfeit present. Counterfeit gold dust is sometimes so heavily coated with pure gold (by the galvanic process) as to protect the base alloy from the action of nitric acid, hence the necessity of cutting all suspected pieces before submitting to the action of the acid. To remove the acid from the gold, wash with water thoroughly, and dry over the spirit lamp.

TO TEST GOLD DUST BY TOUCHSTONE AND TEST NEEDLES.

The needles are described under the head of *Assay of Gold Bullion*.

Select from the samples several pieces, to represent as fair an average as possible, and divide each of them with a cold-chisel. Then with each piece, using the fresh cut edges, make parallel marks on the touchstone, and lay the pieces of gold on the table in the same succession. Wet the gold streaks on the stone with nitric acid, using a glass rod or the stopper of a coin test. If no reaction takes place, and the streaks look as bright and metallic as before, the gold is at least 640 fine, and probably finer even than that; wipe the stone gently with a piece of soft rag, and apply test acid in the same manner; if there is still no reaction, the gold is finer than 750; if any action is observed, the fineness is between the two. Test acid is made by mixing ninety-eight parts of pure nitric acid of thirty-seven degrees Beaumé with two parts of hydrochloric acid of twenty-one degrees, and twenty-five parts of distilled water by measure. If the golden streaks are not acted on by nitric acid, nor by the test acid, take a touch needle marked 700, and make a similar streak on the stone below that made with the samples. Compare the color, and then progress with other needles, both copper and silver, using a higher mark each time, until a color corresponding to that of the samples is had; an approximate knowledge of the quality of the gold will thus be obtained.

But, should nitric acid cause any change in the appearance of the streaks on the touchstone and the preliminary tests in the watch glass indicated copper, try the copper needles and apply them in the reverse order until you hit the color, and find a needle, the streak of which is acted upon in a similar manner by nitric acid. If silver was indicated, use the silver needles. Considerable practice and a good eye are required to obtain accurate results with the touchstone, but this is soon acquired.

Gold dust and retorted amalgam should also be examined for mercury. This is done by putting a small fragment into a glass tube, closed at one end, observing that it falls quite to the bottom. Place the end of the finger loosely over the opening, and heat the closed end of the tube where the piece of gold lies, in the flame of the spirit lamp. If mercury is present, a bright ring will form in the tube above the assay. Upon examination with a magnifying glass, the ring will be found to consist of the minute globules of mercury. To be certain, make a scratch with a file below the ring, and break off the closed end of the tube. Place the end of the now open tube in a few drops of water in a watch glass, and then with a feather, or small stick, the sublimate may be brushed into the water, and by gently shaking, be caused to coalesce into a single globule, in which form it cannot be mistaken for any other substance.

ASSAY OF GOLD BULLION.

Absolutely accurate assays of gold bullion require care, skill, and first-class apparatus. The skill may soon be acquired by practice, but the apparatus must not only be of the very best quality but must be kept in the most perfect state of adjustment. It is not enough to purchase chemicals which are marked "pure," or a balance, supposed to be accurate. The chemicals must be tested, and the accuracy and adjustment of the balance and weights verified before correct results can be certain.

The process of assaying gold bullion is divided into several operations as follows: Melting the crude gold and casting the bar, cutting the assay chips, the assay proper, calculating the results, and stamping the fineness and value on the bar.

For melting, a wind furnace is best, but a good coal stove, such as used in offices, will answer the purpose if the amount operated upon be small. The wind furnace is a square box of fire-brick, built in the form of a cube of three-foot face, with an opening in the center of the upper face. The firebox is about a foot square and fourteen inches deep, provided with an ash pit, movable grate, bars, and sliding cast-iron cover. The flue should be a horizontal opening, about three by six inches, near the top of the firebox, and connected with a chimney at least thirty feet high, to insure a good draft. The furnace can be built by any bricklayer of ordinary skill and judgment. No mortar should be used in laying the fire-brick, but good clay, mixed with a portion of coarse sand substituted.

Gold is generally melted in a black lead crucible. Before such a crucible can be safely used, it must be annealed. Were this neglected, and it should be placed in the fire without this precaution, it would soon fly to pieces. This is caused by the water it contains being converted into steam; and the structure of the material being such that the steam cannot make its escape, destruction of the crucible follows. It is best to commence annealing the crucible some time before it is wanted. It should be set near the hot furnace for several days and turned occasionally. When the fire is nearly spent, it may be placed, rim downward, upon the hot sand in the pan generally placed on top of the furnace. A day or two of such treatment will make it safe to hold it over the open furnace by the aid of the crucible tongs or poker. After it has been frequently turned, and is hotter than boiling water, it is safe to place it, rim downward, upon the burning coals. When the rim is red hot, all danger is passed, and it may be turned and placed in position for the reception of the gold.

If the fuel is charcoal, it will be best not to use small pieces, or at least not coal dust. Pieces the size of an egg, or larger, will make the best fire. When the crucible becomes red hot, a long piece of quarter-inch gas pipe is used to blow out any dust or ashes that may have fallen into it. A cover is then placed on the crucible, and lumps of coal built up around it with a long pair of cupel tongs.

When the crucible has attained a full red heat, one or two spoonfuls of borax, wrapped in paper, are placed in it, using the cupel tongs. When the borax has melted a small quantity of gold dust, also wrapped in paper, is placed in the crucible in the same manner. Several portions may be thus added, according to the size of the crucible. A fresh supply of charcoal must be built up around the crucible when required, the cover having been previously replaced. When the gold has melted down, more is added in the same manner, until the crucible has received all that is to constitute the bar. In the meantime, the ingot mold, in which it is intended to cast the gold, must be made smooth and clean inside. This is best done by rubbing with sandpaper and oil, or with a dry piece of pumice stone. It is then wiped dry and clean with a rag, oiled slightly, and placed on the edge of the furnace in such a position that it may become quite hot; not so hot, however, as to approach redness, nor to cause the oil to burn.

When the gold is in a fluid state in the crucible, the mold must be placed on a level surface and oil poured into it. To make a clean bar, it will be found best to use considerable oil—sufficient to cover the bottom of the mold to the depth of at least one fourth of an inch. The mold should be turned in such a manner as to allow the oil to flow to all parts of its interior, and then placed again level and in the position it is to occupy while casting the gold. If the gold is clean, and the quantity less than fifty ounces, it is best not to attempt to skim it. Two spoonfuls of nitrate of potash may be added, and one of carbonate of soda, and the whole allowed to melt and flow over the surface of the gold. When very hot and the slag perfectly fluid, the crucible is lifted from the furnace and with a bold and steady hand poured into the mold, the crucible being held for a little time in an inverted position, to allow the last portion of gold to flow from it. The oil inflames and remains burning on the slag, which flows evenly on the surface of the gold. If the mold is clean, and of the right temperature, and if sufficient oil is used, a clean bar will result. A little practice will enable the operator to hit the exact conditions. The oil used should be a cheap animal oil; common whale oil answers every purpose; lard oil is also well suited. Coal oil is too inflammable as well as dangerous, and should never be used. When cold, the bar falls easily from the mold; a slight tap with a hammer separates the slag, and the bar may be cleaned with water and nitric acid, or, if necessary, with sand and a suitable brush. A good plan is to place the bar in the furnace until it becomes nearly red hot, and then to quench it suddenly in water. This will be unnecessary if proper precautions have been observed in preparing the mold.

When the gold is very impure—which is the case when in the form of retorted amalgam which has not been properly cleaned—a different method of treatment should be adopted. A larger sized crucible will be required. Three or four times the amount of flux must be put in, with the addition of a spoonful of carbonate of potash. A skimmer must be prepared by forming the end of a large wire, about the size of a common lead pencil, into a spiral about an inch and a half in diameter, and bending it so that when the skimmer is let down vertically into the crucible, the spiral will lie flat upon the surface of its contents. A bucket of water is set near the furnace, and, when the slag has become fluid, and it is beyond question that the gold has become perfectly melted, the skimmer is touched to the slag and gently moved from side to side; a portion of the slag adheres to the iron, the skimmer is removed and plunged into the water, and immediately replaced in the crucible; an additional portion attaches itself to the skimmer, which is again quenched in water. This is repeated until a large portion of the slag is removed, and a new charge of flux, consisting, this time, of borax and nitrate of potash, is allowed to fuse upon the surface of the gold. The first flux is removed from the skimmer by a slight blow with a hammer, and the crucible is skimmed with it as before. This must be repeated until all iron and other impurities have been removed, and the surface of the molten gold appears, when exposed, clean and reflective as a mirror. It may then be poured into the mold, as described before. Care should be taken not to dip the wet skimmer beneath the surface of the gold, or an explosion will take place.

In large meltings it is customary always to skim the gold before pouring, and so far to remove the slag that any remaining portion may be left on the sides of the crucible, and the gold only allowed to flow into the mold. This requires some skill and considerable practice. As it is imperative that the bar should be homogeneous to insure a correct assay, it is usual to mix the melted gold thoroughly before pouring. This is done in the large way by stirring just before lifting from the furnace. It may be done with an iron rod, with a piece of black lead held with the tongs, or with a clay stirrer made specially for that purpose, in which case it will be necessary to allow it to remain in the crucible until it has acquired the temperature of the fused gold; otherwise, a portion of the gold may attach itself to the stirrer and be removed with it. In small meltings it will be found sufficient to mix the gold by giving the crucible a rotary motion while holding it with the tongs just previous to pouring. This must be done so quickly that the crucible has no time to cool. For very small fusions it is best to use a small Hessian crucible, and, when the gold is melted with plenty of flux, to set it aside to cool, and then break the crucible and separate the pieces of crucible and portions of slag by slight blows of a hammer on the edges of the button. It is very difficult to pour small quantities of gold without loss from portions remaining on the sides of the crucible.

When the bar is clean, a small portion must be taken from different parts for assay. It is customary to cut from opposite corners with a cold-chisel, but this is extremely clumsy and in every way inconvenient. If the bar is brittle, a much larger piece may break off with the chip than is required. If the proper sized chip is cut off successfully, it is likely to fly away and be lost. A better way is to bore into the bar in different parts with a small drill. This may be done in a lathe, or by means of a ratchet drill. The bar should be placed in a clean copper pan, so that no loss may occur; the surface borings, resulting from the first revolutions of the drill, should be rejected. Those that follow, to the extent of a little more than one gram, are to be placed in a suitable vessel and carefully preserved for assay. Before cutting or boring the bar, the number of the assay should be stamped upon it, and the same number placed with the clippings. This number should represent the bar through every stage of the assay by which its value is ascertained. Some assayers stamp the initial of their name on the cut faces, so that no portion can be removed after it leaves their hands.

The next step is to ascertain the weight of the bar in troy ounces and decimals. This must be done with the greatest accuracy. A good bullion balance is much to be desired; but a bar can be weighed on a defective balance if it is sufficiently delicate to turn distinctly with the hundredth part of a troy ounce. This method of weighing is called counterpoising, and is conducted as follows:

The beam must first be brought to a level by putting sand, small shot, or other convenient weights into the lightest pan. When in perfect equilibrium, a small weight is placed in one of the pans to test the delicacy of the movement, and if satisfactory the bar is laid in one pan and the equilibrium restored by putting any convenient substance, as sand, into the other. The bar is then removed and ounce weights put in its place, which will be the exact weight of the bar, all errors of the apparatus being corrected by counterpoising, which will be evident to the reader without further explanation. Of course the ounce weights must be proved by experiment to be correct among themselves.

It is sometimes impossible to obtain troy ounce weights, in which case avoirdupois may be used. The same rule as to accuracy applies equally to them. Each pound equals 14.5833 troy ounces. An excess of even pounds must be made with ounces and decimals, which can be prepared by any person of moderate mechanical skill. The value of an avoirdupois ounce is 0.911458 ounces troy, or one sixteenth of a pound. To make the calculation, it is only necessary to multiply pounds by the former and ounces by the latter factor, and add the two together. The following table may be used to facilitate the calculation:

Avoirdupois.	Troy Ounces.	Avoirdupois.	Troy Ounces.
1 ounce	0.911458	13 ounces	11.848958
2 ounces	1.822916	14 ounces	12.760416
3 ounces	2.734374	15 ounces	13.671874
4 ounces	3.645833	1 pound	14.583333
5 ounces	4.557291	2 pounds	29.166666
6 ounces	5.468749	3 pounds	43.749999
7 ounces	6.380208	4 pounds	58.333333
8 ounces	7.291666	5 pounds	72.916666
9 ounces	8.203124	6 pounds	87.499999
10 ounces	9.114583	7 pounds	102.083333
11 ounces	10.026041	8 pounds	116.666666
12 ounces	10.937499	9 pounds	131.249999

Suppose the bar to weigh twelve pounds and nine ounces, set the figures down thus:

10. pounds.
2. pounds.
.9 ounces.

12.9

Look for ten pounds in the table, which will be the same as one pound with the decimal point moved one place to the right; 145,833, opposite two, will be found 29,166; nine ounces will be found to be 8,203, which are to be added as follows:

10. pounds	145,833
2. pounds	29,166
0.9 ounces	8,203
12.9—weight of the bar.	183,202 troy ounces.

When decimals of an ounce are calculated, the values may be taken from the first column of the table. Suppose the decimal to be .7, or 7-10, move the decimal point in the seventh line one place to the left, and the result will be .6380208, which is to be added to the sum of pounds and ounces.

The above method of weighing is sometimes convenient in isolated mining localities where no accurate bullion balance or large sets of troy weights can be obtained.

A table having been given to calculate troy ounces from avoirdupois pounds, the following table has been prepared to reverse the operation, and it will in many cases be found convenient:

Table for Changing Troy Ounces to Pounds and Decimals Avoirdupois.

Troy Ounces.	Pounds—Avoirdupois.	Troy Ounces.	Pounds—Avoirdupois.
1	.06857	6	.41142
2	.13714	7	.47999
3	.20571	8	.54856
4	.27428	9	.61713
5	.34285		

Gold is always estimated in troy ounces and decimals. A convenient set of weights may be constructed as follows:

Ounces.	Decimals.	Ounces.	Decimals.
500	0.500	10	.010
300	.300	10	.010
200	.200	5	.005
100	.100	2	.002
50	.050	2	.002
20	.020	1	.001

The weight of the bar being accurately ascertained, the next step will be "the bullion assay proper."

The method of conducting the assay is as follows: The assayer seats himself before the balance, having the clippings in a convenient position inside the case. Half a gramme weight is placed in the right-hand pan of the balance, and portions of the clippings in the other until nearly correct, but the gold should be in excess. The largest piece is then removed by the aid of a pair of pliers, and touched against a clean file, by which a minute portion is removed. By careful manipulation nearly the exact point will soon be obtained, but with the greatest care; if the balance is delicate, it will be found nearly impossible to adjust the weight so perfectly that the index will not point either one side or the other of the zero. In such a case, it will be necessary to make a memorandum of the error and mark it with the number of the assay, and in weighing the cornet to take the same reading of the index.

The gold is removed from the balance-pan and carefully folded in a piece of lead foil an inch square. Care must be taken in preparing this lead, that it is as pure as possible. It must contain no trace of gold. Its purity being established, it is easily prepared by rolling out to a uniform thickness and cutting into inch squares; these should always be prepared by the assayer himself, and kept on hand in sufficient quantity. Two assays must be prepared, as described above. Two small, well made cupels are then to be placed in the muffle, and when hot, a piece of pure lead, weighing three grammes, is placed in each, which will soon melt and begin to "drive"—that is begin to be absorbed by the cupel—the assays are then to be added, using the cupel tongs. When perfectly melted, the cupels are drawn forward to that point in the muffle which experience has shown to the assayer that cupellation progresses most successfully. When the cupellation is finished, and the buttons have assumed a brilliant yellow metallic luster, they are removed, hammered slightly on their edge on a clean anvil, and examined carefully with a magnifying glass to see that all bone ash has been removed. The two buttons should weigh exactly alike; if this should not be the case, the heaviest one must be examined carefully to see if any particle of bone ash may have been overlooked. If this should fail, there is no recourse but to make another assay, which should agree with one of the first. The correct weight of one of the buttons in half milligrammes represents the total fineness, or the gold and silver in the bar, expressed in thousandths.

The weight of the buttons being carefully noted, pure silver is added and they are again cupelled. It has been found that silver cannot be dissolved out of an alloy of that metal with gold, unless the proportion of silver is at least two and one half times that of the gold. If a larger proportion is used, the gold is left in the form of a powder, and cannot be dried and weighed without danger of mechanical loss. If less, the gold protects the silver, and the action of the acid ceases, while some of the silver remains undissolved. An alloy of three parts of silver to one of gold was formerly taken, from which the common term quartation comes, but of late years the above proportions have been found to be best.

As the button resulting from the first cupellation may contain silver, it will be necessary to ascertain if such is the fact, and, if so, in what quantity it may be present.

A preliminary assay is easily made by means of touch needles, to be described. When great accuracy is required—as in case of many assays of gold from the same mine—half a gramme may be cupelled with five or six parts of silver and the proper quantity of lead, the resulting button rolled out and boiled in nitric acid, as will be fully described hereafter. With the data so obtained it will be easy to make up the proper alloy for the actual assay. By this test the gold will be obtained as a powder, but the results will be sufficiently accurate for a preliminary assay. For all practical purposes the touch needles will give results sufficiently exact, and may be confidently used after a little practice.

Two sets of needles will be required, one, the alloy of which is silver, the other copper. These needles can be made by any handy person. Absolutely pure gold and silver are required.

The ordinary plan is to draw out copper wire through a wire plate with square holes, to about the size of the square point of a tenpenny nail. This is cut into lengths of about two inches—five of these constitute a set. It is best to commence each with pure gold; but only one is actually necessary, for pure gold is, of course, the standard of either set.

Weigh out ten grains of pure gold, melt before the blowpipe in a cavity in a piece of charcoal, hammer square and solder to the end of one of the square wires. This requires some skill and an understanding of the nature of this kind of soldering, but any jeweler can do it from this description. When soldered, file down even with the sides of the wire, and stamp on the wire 1000, which represents pure gold. For the other end make an alloy by weighing out very carefully nine grains of pure gold and one grain of pure silver; these are melted on charcoal together—care being taken that sufficient heat is produced to render the alloy perfectly fluid—hammered square, and soldered in the other end of the first needle. This is stamped 900. One needle being complete, the others are made in the same way, as follows:

Grains Gold.	Grains Silver.	Stamped.
8	2	800
7	3	700
6	4	600
5	5	500
4	6	400
3	7	300
2	8	200
1	9	100

The second set is made in exactly the same way, except that copper takes the place of silver in the alloy.

The only source of error is the heating of the solder so hot that it melts the alloy, and by fusing with it a new and unknown alloy is formed. The alloy should be considerably larger than the needle so that it can be filed down, thus removing the solder from all parts except where the copper is joined to it.

A touchstone is best purchased, but the black quartz stones found in the beds of some rivers and creeks will answer the purpose if they will scratch glass, and acids have no effect upon them. A smooth face should be formed by grinding. The true touchstone is a variety of black quartz called basanite or Lydian stone, from a well known locality. It is also found in Bohemia, Saxony, and Silesia.

The touch needles are used for comparison, as follows: The alloy to be tested is rubbed on the touchstone, leaving a characteristic metallic streak; the needles are then compared with the streak on the stone by placing them in succession beside it, until one is found which appears the same in color to the eye; a comparative streak is then made with this needle, parallel and near the alloy, both of which are then closely observed under a common lens; if they exactly compare, the alloy is supposed to be the same degree of fineness as the needle; if not, a similar experiment is made with needles finer or otherwise, as the case may be; a glass rod dipped in strong nitric acid is then touched to the stone covering a portion of both streaks; the action of the acid gives confirmatory evidence as to the fineness of the alloy.

An example will fully explain the manner of making up the alloy in the bullion assay when the fineness is made known by actual experiment.

Suppose the button is found to weigh 972 one-thousandths of the unit, according to the weights used, and by preliminary assay, the gold 896 fine; which is 896 thousandths. It is evident that there is 896 of gold and 76 of silver in the alloy, very nearly. If these results were accurate, there would be no use of proceeding any further, but the results are only sufficiently so to insure a good alloy for the continuation of the assay. Multiply the gold by 2.5, which will give the silver required to be added to the gold, $.896 \times 2.5 = 2{,}240$; but there is already .076 parts of silver with the gold, which must be deducted, therefore 2,164 is the amount of silver to be added to the button: $.896 \times 2.5 - 76 = 2{,}164$.

In case the touch needles are used, a different calculation will be necessary. The following formula is self explanatory:

Let "A" equal the weight of the button after cupellation in millegrams.
" B "=The fineness of the gold in A, as determined by the touch needles.
" C "=The gold in the button approximately.*
" D "=The silver required for parting (two and a half or three parts).
" E "=The silver already in the button.†
" F "=The weight of the silver to be added to the button for parting.

* $A \times B = C$ } Then $C \times D - E = F$.
† $A - C = E$ }

The silver used need not necessarily be chemically pure, but it must contain no trace of gold. It is convenient to roll it out in thin strips to be cut with scissors as required.

When the proper amount of silver is weighed out it is to be folded in lead foil, with the gold button, and cupelled as before.

Two of the gold buttons which weighed alike in the first cupellation, must be alloyed with silver and treated as above. It is not absolutely necessary to cupel the alloy the second time, but it is convenient to do so while the muffle is hot—it insures a malleable button, which can be rolled out without breaking, and there is more certainty, in unskillful hands, of perfect fusion, and, consequently, perfect mixture of the two metals, which must be effected to obtain perfect results. But the gold and silver may be melted together in a cavity in a piece of charcoal, by a person skilled in the use of the blowpipe, with the same certainty of success as when the muffle is employed.

The buttons resulting from the second cupellation are removed from the cupel, hammered slightly on the edges, to remove bone ash, and afterwards flattened on an anvil by blows from a small hammer, the last blow being given near one edge, to make that part thinner, in order to facilitate the rolling process which follows.

At this stage, before rolling out the alloy, the buttons should be annealed; which can be done in the muffle, if still hot, or upon charcoal, with the flame of a spirit lamp urged with a blowpipe. They are then rolled out into ribbons about three inches long, and rolled up into a spiral form upon a glass rod or lead pencil. A slight pinch, after the rod is removed, will prevent their unrolling. They are then ready for treatment with acid.

The *cornets* are next placed in clean glass flasks and covered with about a fluid ounce of twenty degree nitric acid, placed on the sand bath which acts as cover of the furnace, or on a small sand bath supported on the ring of a retort stand over a spirit lamp, and boiled until no more red fumes are evolved. A folded piece of paper, or a pair of wooden tongs, are used to lift the flasks and pour the acid carefully into some convenient vessel kept to receive it, as the silver is valuable, and may be recovered when a sufficient quantity has accumulated. The same quantity of thirty degree acid is then poured into each flask, and, being placed on the sand bath, again boiled. A small piece of charcoal, which must not contain chlorine, is put into each flask to prevent bumping. After five minutes boiling, the acid is poured off, and each flask is filled up with distilled water, which is carefully rejected, and the flasks again filled with the distilled water, this time quite to the brim. Over the mouth of each flask a dry cup is placed, mouth downward, like a cap, and the flask and dry cup inverted together. The cornet falls gently and without breaking to the bottom of the cup. The flask is then gently raised until on a level with the edge of the cup, when, with a quick side motion, the flask is removed and held for a moment to allow the water to fall from it, when it is set aside. Both flasks are treated in the same way. The water in the dry cups is then poured off without disturbing the cornets, after which each cup with cornet is heated red hot in the muffle. The gold will be found to have regained its natural color, and can be removed without danger and taken to the scales to be weighed. If the operation has been skillfully conducted, the result is practically pure gold. It must be weighed accurately, noting any memorandum regarding the position of the index in weighing out the bullion in the first operation. Its weight in half milligrammes will represent the fineness of gold in the bar, expressed, as before, in thousandths.

Suppose the total fineness to be 970, and the fineness of gold as found by assay, to be 898, by subtracting the result from the first, the fineness of silver will be found to be 072. Now, as one ounce of pure gold is worth $20.6918, one one thousandth will be worth $0.0206718, therefore, an ounce of alloy, containing 898 parts of pure gold, would be worth 898×0.0206718, or $18.56327. The last three decimals may be disregarded unless the bar is very large.

The value of the silver is obtained in the same way. An ounce of pure silver is worth $1.2929, and one thousandth equals $0.0012929. This, multiplied by the fineness of silver as found, would give the value of the silver in each ounce of the bar.

To facilitate this calculation I have computed a table by which multiplication is avoided:

Table for determining the Value of Gold and Silver Bullion.

Fineness.	Gold.	Fineness.	Silver.
.000½	.010335917312	.000½	.000646464646
.001	.020671834625	.001	.001292929292
.002	.041343669250	.002	.002585858584
.003	.062015503875	.003	.003878787876
.004	.082687338500	.004	.005171717168
.005	.103359173125	.005	.006464646460
.006	.124031007750	.006	.007757575752
.007	.144702842375	.007	.009050505044
.008	.165374677000	.008	.010343434336
.009	.186046511625	.009	.011636363628

The manner of using this table is the same as a similar one before described:

800 same as 008 decimal 2 places right	=	$16.53746
090 same as 009 decimal 1 place right	=	1.86046
008	=	.16537
898 value of gold per ounce	=	$18.56329

SILVER.

070 = same as 7—1 place right	$0.0905
002 =	.0025
072 =	$0.0930
Value of gold per ounce	$18.5632
Value of silver per ounce	.0930
Total value per ounce	$18.6562

These results, multiplied by the number of ounces and decimals of an ounce the bar weighs, would be its value in dollars and cents. Suppose the bar weighed 100 ounces:

Value of gold	$1,856.32
Value of silver	9.30
Total value	$1,865.62

The following must be stamped on the bar before it can be sold:

Number of the assay; name of assayer; weight of bar in ounces and decimals; fineness of gold; fineness of silver; total value of the bar in dollars and cents.

When several assays of gold bullion are to be made together, the plan of operation is somewhat modified. Let it be required to conduct nine assays together. Certain tools and appliances will be necessary which have not yet been described.

A piece of hard wood is made about four inches square and an inch in thickness. On one side a portion of the wood projects to serve as a handle; nine half inch holes are bored in the square part nearly through the thickness. On the under surface in each corner a small knob is screwed which serves as feet to raise the board above the table. In each of the holes is to be placed a tube of glass closed at one end. The other end of each is cut off square, and ground flat on a grindstone or emery wheel. The size of the tubes is such that they can be easily removed and replaced in the holes. The tubes are a little more than an inch long, so that they can be easily grasped with the finger and thumb when it is required to remove them from the holes.

Each of the tubes are marked with a letter of the alphabet, from A to I inclusive. This may be done with a writing diamond, or with a corner of a freshly broken file. Near each hole on the board is also stamped a letter, using the same as those marked on the tubes. For want of a better name, let this be called a "tube rack."

On commencing the assay, the bars are first stamped with the running number of the assays, to correspond with the entries in the record book of the assay office. Similar entries are then made on a small memorandum book, and to each entry letters are added, thus: No. 794, A; No. 795, B; No. 796, C, etc. The bars are then all taken to the anvil, and assay chips cut from them, or borings taken in the manner before described. The clippings from the bar stamped 794 must be put into the tube marked A, which is then placed in its proper hole; those from 795 in the tube marked B, etc. The bars are then set aside, and the tube rack taken to the balance. Here other apparatus will be required. A square block of wood, with a single hole bored in it the same size and depth of those in the tube rack, and another square piece of wood, with handle, of the same size and thickness as the tube rack, but instead of holes, nine hemispherical cavities are cut, each of which is about an inch in diameter and half an inch deep. These cavities are marked with the same letters, and in the same succession, as those of the tube rack. The tube marked A is lifted from the rack and placed vertically in the hole in the second block, which serves for a temporary stand for it. The clippings that are contained in it must previously be poured out on a clean piece of paper, placed, for convenience, inside the balance case. After the assays are weighed out, the remaining gold is put back into the tube. The assays, in their leaden envelopes, are placed in the cavity marked A. B is then treated in the same way, and so on through the whole set.

Nine cupels are then marked and placed in the muffle in the same order and with the same letters. The object of marking the cupels is, that it is sometimes necessary to change their position in the muffle, and even to take one or more of them out, before the others are finished.

The manner of marking the cupels is as follows: Some red chalk is ground fine, mixed with water, and kept in a small wide-mouthed bottle for use. When required to mark cupels, the contents of the bottle are stirred and applied with a small camel's hair brush. The cupels should be marked on two sides.

When the cupels are taken from the muffle, they are placed in a rack of sheet iron divided into nine compartments, and when the buttons are removed they are placed back into the cavities in the board from which they were taken when placed in the cupels. This serves to convey them to the balance, when they are weighed, alloyed with silver, and returned to the muffle for second cupullation. It will be seen that to this stage the assays are always kept in compartments bearing their mark, and with ordinary care no mistake can occur.

When the assays are alloyed with silver and rolled out, the proper letter is stamped on the end of each, somewhat deeply. The assay is then rolled up in spiral form in the usual manner, commencing at the end which is not stamped. This letter will be as distinctly seen after boiling in acid as before. The cornets are then placed in flasks, boiled with acid, and dried in the usual manner.

It has been recommended to place all of the cornets in one flask, and after boiling, to invert it in a somewhat capacious dish of water; to pick out the cornets with a pair of forceps, and to anneal them altogether in the muffle on a tile. I have never tried it, but I consider it to be unsafe, as with the best of care the cornets are sometimes broken in the boiling. The elegant plan of boiling a number of cornets in baskets of platinum wire, in one vessel, is open to the same objection.

Before attempting to make a gold bullion assay, the following sources of errors should be known:

First, those errors which may result from the non-adjustment of the balance and weights. If the balance is sufficiently delicate, *most* of the errors may be disregarded if the weights are always placed in the same pan; and *all* of them by counterpoising, which has already been described. Such weighing will do in extreme cases, but no assayer should be without a first-class balance.

Any convenient unit divided into 1,000 parts may be used in the bullion assay. For gold assays the unit is usually one half gramme so divided, while for silver, being less valuable, one gramme is used. It is not safe to trust the weights of any maker, no matter how celebrated he may be, but the assayer should test their accuracy for himself.

Another source of error is a slight loss of gold on the cupel. This error may be corrected by cupeling a proof in the muffle at the same time with the assay. The proof is pure gold and silver, as near the composition of the assay as can be made. The loss of the proof is supposed to be equal to that of the assay and is to be added to its weight.

The manner of using the proof is as follows: First, consider what will be the average fineness of the assays being conducted. The preliminary assays will furnish the data. Let it be supposed that this average will be .950, weigh out nine hundred and fifty thousandths of pure gold, alloy it with two and a half its weight of silver, and cupel it in the muffle with the nine assays, boil with the same acid, and under exactly similar circumstances, heat to redness in a dry cup and weigh. It will generally be found to have increased in weight, owing to the surcharge being in excess of the mechanical loss. What the proof has gained in weight must be subtracted from the other assays; when many assays are to be made from the same mine, an alloy of copper, silver, and pure gold must be made up as nearly identical as can be with the composition of the bullion, and this alloy used as a proof. Of course a full unit must be employed in this case.

A third error may result from using an impure acid, causing a loss of gold, from its solubility in nitric acid containing chlorine. This error may be avoided by always having a little silver dissolved in the acid. It is too expensive and wholly unnecessary to employ chemically pure acid in the gold assay. Good commercial nitric acid, treated in the manner to be described, will answer every purpose. Acid of two grades of strength must be prepared from the strong acid, one of twenty degrees Beaumé, and one of thirty degrees. It is best to dilute all the acid to thirty degrees with distilled water, and to add a few drops of a solution of nitrate of silver. Let it remain twenty-four hours to settle, and add a few more drops of silver solution. If no cloudiness appears, the diluted acid is allowed to stand covered for a week, and the clear portion decanted from the slight precipitate of chloride of silver. One third of the acid is then diluted with distilled water to twenty degrees. The process of diluting is easily performed by the aid of a hydrometer. A portion of the acid is poured into a cylinder deep enough to float the hydrometer, which will sink to a certain point according to the density of the acid. The strength in degrees can be read on a scale on the inside of the stem.

Every assayer should possess a hydrometer and cylinder, and dilute his acid himself. The acid so prepared should be distinctly labeled, and the fact of its containing silver noted on the label. It should be used for no other purpose.

Still another error to be guarded against is the surcharge, which is the small amount of silver which always remains in the cornet, no matter how carefully the manipulations may be conducted. There are several tables computed to correct this. The finer the gold the greater will be the surcharge.

The following results were obtained by a series of careful experiments in the Paris mint, by weighing out accurately gold and silver, both absolutely pure, to represent the fineness written in the first column. The results in the second column show the surcharge when they are greater than the fineness, and the loss on the cupel when they are less. The assays were:

900	900.25	400	399.5
800	800.5	300	299.5
700	700.0	200	199.5
600	600.0	100	99.5
500	499.5		

Pure gold for proofs may be obtained in the manner described under the head of the chemistry of gold. The pure metal should be melted, rolled out thin, cleaned from oil, cut into shreds, and kept in a clean bottle for use.

There are a few points to be borne in mind in making the bullion assay to insure success. The alloy of gold and silver should not be rolled out too thin, as it is likely to be broken when this precaution is disregarded. The cornet must never be weighed without being heated to redness. Simple drying will not give correct results. In boiling with acid, the flasks should be turned on their sides at an inclination of 45° to prevent loss of acid in the event of sudden ebullition. A graduated measure should be used for the acid, that the amount put in each flask may be equal. Common water should never be used in washing the cornet, as chloride of silver is formed in the pores of the gold, which cannot be removed, and which being insoluble in acid remains in the cornet and gives incorrect results.

RETORTING GOLD AMALGAM.

For small operations, the retort used is a deep cast-iron vessel, shaped somewhat like a bowl. The top edge is planed level, and upon this fits a cover, also planed true, so that when put together, the two parts form a perfect joint. From the cover an iron tube rises and bends downward, at an angle of about twenty degrees from the horizontal. The cover is fastened by a clamp and set screw. A mixture of wood ashes and clay is prepared by mixing them into a thick paste with water. When all is ready the balls of amalgam are placed in the bowl, the mixture of ashes is put thickly around the edge, the cover fitted, clamp adjusted, and the whole firmly fixed by means of the set screw. All the superfluous luting is removed, and the retort placed in a furnace over a moderate fire. The end of the pipe must dip just below the surface of water placed in any convenient vessel; if the fire is kept well under control there will be no necessity for cooling the pipe. It sometimes happens that when the amalgam has been imperfectly cleaned, the gold will stick to the retort; this may be obviated by chalking the interior of the retort, or putting a piece of common writing paper under the amalgam balls. However, when the amalgam is clean and has been thoroughly worked over, the gold will come out easily.

A very convenient way to retort is to drive two small stakes into the ground, and to fasten a small iron rod to each, at a convenient height; upon this the retort is hung, and around it a fire of small wood built. When the retort has attained a dull red heat, and no more mercury distils over, the fire is put out and the retort allowed to cool; the cover is taken off and the bullion removed. If the amalgam has been properly cleaned, it will be found after retorting, to be metallic in appearance, and of a gold color. It is ready for the melting pot as soon as taken out.

It is never safe to open the retort before it is cool, nor will it stand being cooled in water. Many persons have done themselves great injury in their impatience to see the result of an important run, by opening the hot retort, and inhaling the poisonous mercurial fumes.

In extensive runs, when the clean-up is large, a retort of cast iron, made something like a gas-house retort, with movable front door, is set in brick work and furnished with a cooler surrounded by constantly changing water.

Inexperienced miners find it difficult to separate iron from amalgam, which is too often put into the retort without proper cleaning, in which case the bullion comes from the retort looking like soot; yet the management of amalgam is simple, and when once understood there need be no failure.

Many experiments have been made to clean improperly retorted gold bullion by the use of acids. This is nearly always attended with loss of gold or is inoperative. I once saw a miner in Mariposa County cleaning crude bullion just from the retort, by boiling in aqua regia—nitro-muriatic acid—after which he threw the acid away!!

Some miners wash amalgam as taken from the bags, first in diluted sulphuric acid, and then with nitric acid supposed to be pure.

It is almost needless to say that such treatment shows gross ignorance. It is better to properly clean the amalgam and to flux off any accidental impurity in the crucible.

GOLD IN CALIFORNIA.

Gold exists in nearly every county in California. To enumerate all the localities in detail would be useless. In the second report of this office, the subject of placer, hydraulic, and drift mining was very fully treated.

QUARTZ MINING.

To treat the subject of quartz mining in California with the fullness and completeness that its importance demands, would require more time and means than the State Mineralogist has now at his disposal; wherefore it has been thought best to defer the whole matter till his next annual report, in the hope that he will be able in the interim to collect such data as will prove of interest to the public at large, and of special service to the millman and miner. While so reserving this subject for future consideration, it may be observed that the business of quartz mining is in a very healthful and promising condition in this State. Purged of such elements of speculation as formerly entered into it, this industry is now being carried on with something of that system and careful attention to details that is deemed essential in the prosecution of other legitimate pursuits. The inordinate expectations of earlier times have been moderated, and economy has largely taken the place of lavish expenditure, while theories have everywhere been subordinated to practical experience, many valuable improvements having, meantime, been introduced into every department of the business. How large these gains have been is denoted by the fact that many abandoned mines are again being worked, while ores once rejected as worthless are now being reduced with profit. In some instances quartz rock is being mined and milled in California that pays on an average not over three dollars per ton, whereas twenty dollar rock was at one time considered too low grade to warrant its removal from the mines. While three dollar ore can, as a matter of course, be handled to advantage only where the conditions are exceptionally favorable, still, we have in this State such infinite quantities of four and five dollar ore that very rarely will it be found necessary to run on a much poorer grade. Although much of the gold in our California ores is found combined with sulphur, not until recently have effective means been adopted for fully saving these sulphurets, nor for a long time had any satisfactory process for their subsequent treatment been devised. All this is now changed or is undergoing a change that must result in a very great saving of the precious metal, a large percentage of which, under the old wasteful system, was lost.

In the mechanical as well as in the metallurgical branch of the business much progress has been made. While the stamp and mortar still holds its supremacy as an ore crushing implement, its province is being invaded by other appliances, some of which, having been continued in use after the most critical tests, may be expected to retain the favor that they have gained with the millmen. And so, of various other mechanisms that have already been adopted, or which are seeking recognition at the hands of the mining public.

For many years it has been the practice of Californians to interest themselves in the mines of Nevada, Arizona, Mexico, and other outside localities. But, with the improved condition of things at home, it may safely be predicted that very little local capital will hereafter seek investment beyond the limits of the State. This growing disposition on the part of our moneyed men to embark their means in the mines of California insures for quartz operations here an early expansion and a prosperous future. That the number of stamps now running in the State will be increased from sixty to eighty per cent within the next ten years seems highly probable, and that the business of quartz mining will hereafter see fewer losses and failures than have attended it in the past may be accounted altogether certain.

PRODUCTION OF GOLD.

Since the grand discovery of gold in California, which occurred January 19, 1848, the value of that metal produced in this State amounts, according to the authorities cited below, to $1,049,323,545, the product for 1884 being by us estimated on the basis of the average product of the preceding two years.

TOTAL PRODUCT OF GOLD IN CALIFORNIA.

Years.	Authorities.	Amount.
1846 to 1868 (inclusive)	W. P. Blake's Report on the Precious Metals, folio 21 (estimated)	$807,000,000
1869	Rossiter W. Raymond	20,000,000
1870	John Valentine	18,682,972
1871	Rossiter W. Raymond	16,167,484
1872	John Valentine	19,049,098
1873	Mining and Scientific Press (October 24, 1874)	18,052,722
1874	John Valentine	17,617,124
1875	John Valentine	16,326,211
1876	John Valentine	16,099,499
1877	John Valentine	15,237,729
1878	John Valentine	17,306,508
1879	John Valentine	18,190,973
1880	John Valentine	17,745,745
1881	John Valentine	17,166,674
1882	John Valentine	15,520,325
1883	John Valentine	13,841,297
1884	Estimated	14,680,806
Total		$1,078,685,167

This, if refined to pure gold and melted, would make about 2,968 cubic feet, and form a cube having an altitude of $14\frac{371}{1000}$ feet, nearly.

The following table, which covers the entire era of gold production in California, giving both the yearly and total output during that period, has been prepared for this report by Dr. Henry Degroot, a painstaking and generally accurate statistician. As will be seen, only round figures have here been employed, since, however, Mr. Valentine may be able to give with exactness the amount of gold received and transmitted by the express company of which he is Superintendent, to attempt the same precision in compiling a table of the total gold product of the State where the data is so uncertain and the means of collecting it so insufficient, would be to pretend to an accuracy not attainable in dealing with this class of facts:

DR. DEGROOT'S ESTIMATE.

Year.	Amount.	Year.	Amount.
1848	$5,000,000	1868	$23,000,000
1849	23,000,000	1869	22,000,000
1850	50,000,000	1870	21,000,000
1851	55,000,000	1871	18,000,000
1852	60,000,000	1872	20,000,000
1853	65,000,000	1873	19,000,000
1854	60,000,000	1874	18,000,000
1855	56,000,000	1875	17,000,000
1856	55,000,000	1876	17,000,000
1857	54,000,000	1877	16,000,000
1858	50,000,000	1878	17,000,000
1859	48,000,000	1879	20,000,000
1860	45,000,000	1880	19,000,000
1861	40,000,000	1881	18,000,000
1862	38,000,000	1882	16,000,000
1863	35,000,000	1883	15,000,000
1864	30,000,000	1884 (estimated)	16,000,000
1865	28,000,000		
1866	26,000,000		$1,160,000,000
1867	25,000,000		

HISTORY OF EARLY GOLD DISCOVERIES IN CALIFORNIA.

Early Fictions and Actual Discoveries.—The belief so generally entertained that the gold discovered at Sutter's Mill in 1848 was the first ever found in California, is erroneous, placers of limited extent having been met with at various points in the country long before that date. As to the early traditions which ascribed to this section of the Pacific Coast a marvelous wealth of the precious metals, they are not only apocryphal, but for the most part wholly fictitious, it having been the custom a few centuries since for the discoverers of new lands to magnify their importance by setting afloat stories of this kind. Thus, Sir Francis Drake, who, in 1579, visited this coast and entered the bay which now bears his name, on his return to England, gave such a glowing account of the country that Hakluyt, a historian of that day, in writing about it remarks that "there is no part of the earth here to be taken up wherein there is not a reasonable quantity of gold or silver"—this being said about the district lying adjacent to Drake's Bay, in which no sign of the precious metals has ever been found. This, then, was a sheer fabrication of the great navigator, unless, to be sure, an entire absence of gold and silver may be construed to constitute "a reasonable quantity" of these metals. Again, in a book published at Lorraine, about the time above mentioned, there occurs the following passage: "The soldiers of Vasquirus Coronatus, having found no gold in Vivola, in order not to return to Mexico without gold, resolved to come to Quivera (California), for they had heard much of its gold mines, and that Tatarraxus, the powerful King of that country, was amply provided with riches." Stories of this kind were rife during the period of the Spanish conquests, having been invented to stimulate the cupidity of the soldiery and encourage all to new adventures.

Of the placers discovered here in early times one was located near the Colorado River, San Diego County; this, the first found, having been discovered in 1775. The site of this find is embraced within the limits of what is now known as the Carga Muchacho mining district, located about fifteen miles a little north of west from Fort Yuma. Situated on a dry mesa, with no water nearer than the Colorado River, twelve miles distant to the southeast, it is not probable that this placer was ever worked much, though some gold has been gathered there of late years; the miners taking advantage of the little water afforded by the Winter rains, in that region very scanty. Some dry washing with machines has also been practiced at this locality. The quartz lodes, numerous in the neighborhood, were undoubtedly the primary sources of these placer deposits. These lodes are quite rich in gold, as is shown by the production made by the Yuma Mining Company, who put up a mill there several years ago, and had prior to June, 1882, taken out $167,000 from 14,000 tons of quartz. With even a moderate supply of water this placer, though not very extensive, could, no doubt, be worked with profit.

The next discovery of this kind made, occurred fifty-three years later at San Isidro, in the same county, gold diggings having afterwards been found on the upper waters of Santa Clara River, and still later in the San Fernando Mountains, both in Los Angeles County. These San Fernando diggings were worked steadily in a small way for twenty years, not having been wholly abandoned until the Spring of 1848. Here considerable gold dust was taken out, to the value, probably, of $150,000, or $200,000. From the other placers mentioned, however, very little was ever collected. Being by no means rich, and but scantily supplied with water, these could, in fact, be worked only in a limited way, and were incapable of paying large wages. Some ten or twelve years ago portions of the gold-bearing gravel in the San Fernando region were worked by the hydraulic process, but the operations not proving remunerative were, after a trial of several years, suspended. There is a talk now of new enterprises of this kind being undertaken in that district; it being the opinion of good judges that under present improved conditions, these gravel banks can be made to pay. A project is also at this time entertained of bringing water from Lake Elizabeth upon the ancient Santa Clara placer, which, with the supply so afforded, it is believed, would give profitable employment for many years to a considerable number of men. Gold gathering in a small way, conducted in some instances by dry washing is, and for many years past has been, carried on all through this San Fernando region, the merchants at Newhall and elsewhere in the vicinity buying small lots of it, for which they pay $17 50 per ounce. Colors, and in some cases, very fair prospects can be found in many of the ravines in this range and along Placenta Cañon, five miles from Newhall, where several small parties are engaged in gold washing, at which business they make good wages most of the year.

TABLE SHOWING FINENESS OF CALIFORNIA GOLD.

Compiled from notes made by John S. Hittell:

PLACER MINES.

Amador County.

Buena Vista	880 to 940
Butte Flat	880 to 920
Clinton	860 to 880
Drytown	860 to 880
French Hill	920 to 930
Humbug	920 to 930
Irishtown	860 to 880
Jackson Creek	860 to 880
Lancha Plana	880 to 940
Mokelumne River	860 to 870
Red Hill	920 to 930
Slabtown	860 to 880
Sutter Creek	840 to 860
Stone Creek	850
Tunnel Hill	920
Willow Springs	860
Brown's Flat	920 to 925
Douglasville	930 to 935
East Columbia	905 to 935
East Columbia (Lower part main gulch)	937
East Columbia (Upper part main gulch)	920
Knapp's Ranch	940 to 950
Matelot Gulch	930
Pine Log	890 to 895
Rensomville	945
Rio Vista	925
San Diego Gulch	940
Sawmill Flat	920
Springfield Flat	950 to 965
Three Pine	935
Under lava beds at Gold Hill	968
Yankee Hill	917 to 930

Butte County.

Blue Lead	950
Butte Creek	880
Bangor	910
Cherokee	970
Dogtown	880
Dry Creek	925
French Creek	870
Forbestown	870 to 880
Forbes Ravine	898
Hansonville	925
Holt's Ravine	935
Honcut	910 to 925
Kimshew	920
Main Feather River	890 to 900
Middle Fork Feather River	890
Morris Ravine	918 to 920
Mooreville	890
Nimshew	900
North Fork Feather River	880
N. S. Flat	910
Oregon House	900
Ophir Flat	875
Oroville	920
Prairie House	925
Rancheria	920
South Fork Feather River	892
Thompson's Flat	940
Walker's Plains	920
Willow Creek	900
Wyandotte	900
Yankee Flat	930 to 950

Calaveras County.

Albany	892
Average	900
Balaklava Hill	900 to 910
Byrne's Ferry	860
Calaveras River	895
Campo Seco	845
Cave City	900
Chile Gulch	890
Central Hill	780 to 785
Chichi	935 to 940
Corral Flat	910
Corral Hill	955
Douglas Flat	900
El Dorado	880 to 890 to 895
Empire Gulch	870
French Gulch	870 to 875
Gravel Ridge	908
Humbug Hill	928 to 940 to 947
Indian Creek	870 to 880
Jackson	935 to 945
Mokelumne Hill	930
Murphy's	888
Old Channel	905
Old Gulch	895
O'Neil's Creek	911
Pennsylvania Gulch	908
Owlsbarron Flat	900
Red Hill	840 to 850
Rich Gulch	895
Salt Spring Valley	700
San Andreas	900
San Antonio	850 to 884
San Domingo	852
Snake Gulch	875 to 880
Tunnel Hill	883
Texas Gulch	895
Union Claim	942
Vallecito	900 to 945
Vallecito Hill	940
Vallecito Flat	900 to 910
Waite's Flat	940
Wm. Holmes	900

El Dorado County.

Aurum City	870
Bottle Hill	888
Brownsville	900 to 800 to 960
Buckeye Hill	910
Buckeye Flat	850
Big Cañon	857
Cañon Creek	885
Carson Creek	910
Centerville	927
Coloma	880
Cosumnes	856 to 880 to 810
Clay Hill	915
Coon Hill	965
Coon Hollow	910 to 970
Cedarville and Mount Auburn	800

Deer Creek	895
Divide, between American and Weber Creek	850 to 900
Dogtown	825
Dross Ravine	850
Dry Creek	850
Empire Ravine	885
Empire Cañon	860 to 880 to 890
Fairplay	800
French Creek	820
French Town	840
Georgetown	860 to 885
Gold Hill	900 to 890
Grizzly Flat	735 to 650 to 865
Green Valley	900
Grizzly Gulch	850
Hangtown Creek	900
Hermitage Ranch	950
Illinois Cañon	890
Immigrant Ravine	910
Indian Diggings	925 to 900
Indian Creek	890
Indian Hill	950
Johntown	885
Kelsey	870
Kentucky Hill	890
Latrobe	890
Matthews' Creek	890
Manhattan Creek	940
Missouri Flat	938
Missouri Cañon	775 to 880
Mount Gregory	830
New York Ravine	915
Otter Creek	880 to 830
Oregon Cañon	890
Pleasant Valley and Newtown	910
Plunkett's Ravine	905
Quartz Cañon	840
Quartz Hill	870
Reservoir Hill	910 to 940
Rich Bar	885
Rock Creek	890
Shingle Springs	852
Smith's Flat	975
Spanish Hill	900 to 950 to 987
Spanish Camp	855
Spanish Dry Diggings	750 to 880
Spring Hill	875
Stillwagen's	675
South Fork of American River	900 to 890 to 875
Slate Creek	850
Sugar Loaf	968
Uniontown	880
Webber Creek	888 to 890
White Rock Hill	965
West Cañon	890

Kern County.

Kern River	659

Mariposa County.

Black Creek	848
Blue Gulch	892
Coulterville, Bear Valley	830 to 840
Flyaway	862
Gentry's Gulch	895 to 898
Horseshoe Bend	855
Maxwell's Creek	861
Merced River	850 to 860
Peñon Blanco	860
Sherlock's Creek	860
Sheldon	760
Solomon's	862

Nevada County.

Alpha	917 to 968 to 908 to 965
American Hill	875 to 885 to 905
Arkansas Cañon	936
Bear River	870 to 878 to 900
Blue Tent	885 to 925
Beckville	848
Birchville	942
Borrjers Ranch	847
Bourbon Hill	840 to 837 to 844
Brandy City	870
Brush Creek	958 to 961
Brown's Hill	906
Buckeye Hill	877
Canada Hill	545
Cedar Ravine	865
Cement Hill	840 to 852
Chalk Bluff	960 to 970 to 976
Christmas Hill	980
Cherokee	910 to 920
Columbia Hill	922 to 961
Colton Hill	890 to 964
Cooley Hill	964
Coyote Hill	850 to 860
Crumbeck Ravine	866
Deer Creek	949 to 950 to 955
Rough and Ready	875 to 880
Diamond Creek	845 to 850 to 890 to 906
Eagle Ravine	848
Eureka	831 to 825 to 835 to 870 to 853
Fall Creek	878 to 880
French Garden	820
French Corral	840
Gold Hill	965 to 970
Gold Cañon	920
Gold Flat	837 to 815 to 831
Gopher Hill	884 to 825 to 925 to 936
Greenhorn	865 to 870
Green Mountain	916
Grizzly Cañon	810
Hunt's Hill	912 to 935 to 913 to 930
Humbug	920 to 953 to 885 to 923
Hitchcock Ravine	825
Illinois Ravine	861
Jackass Flat	859
Jefferson Flat	874
Jefferson Hill	911
Jones' Bar	884
Kanaka Creek	875 to 880
Kansas Hill	836
Kentucky Flat	870
Lawson Flat	877
Liberty Hill	896 to 908
Little York	960 to 892 to 910
Little Deer Creek	845 to 850
Lost Hill	885 to 890
Lost Ravine	870 to 903
Lowell Hill	904
Long Hollow	834
Manzanita Hill	820 to 830
Miles' Ravine	860
Middle Yuba	880
Missouri Bar	883 to 884
Mount Oro	872
Moore's Flat	860 to 875
Montezuma Hill	865
Mosquito Creek	790 to 800
Mud Flat	818
Myers' Ravine	860 to 870
Native American Ravine	884
Nevada City	815 to 840
Newtown	825

North Yuba	890
Omega	950 to 975
Orleans Flat	895 to 910
Oregon Hill	875 to 890
Osborne Hill	841
Peck's Ravine	828 to 833
Phelps' Hill	913 to 920
Pleasant Valley	898 to 904
Picayune Point	850 to 890
Quaker Hill	922 to 960
Randolph Flat	920
Rattlesnake	810
Red Dog and You Bet	903 to 860 to 875 to 930
Relief Hill	931
Remington Hill	920
Rock Creek	869 to 870
Round Mountain	834 to 879
Rush Creek	840 to 850
Sailors' Flat	870 to 875
San Juan North	960
Selby Hill	840 to 865 to 814
Selby Flat	840 to 845
South Yuba	870 to 875
Scott's Flat	922 to 940
Shady Creek	900 to 910
Slate Creek	814
Snow Point	880 to 885
Steep Hollow	900 to 903
Sweetland	900 to 930
Scotchman's Creek	897 to 922
San Juan, Columbia Hill, and Humbug	912 to 935
Timbuctoo	940 to 950
Thomas' Flat	854
Ural	811 to 820
Virgin Flat	886
Washington	870 to 886
Walloupa	852 to 880 to 910
Woods' Ravine	855 to 845
Wet Hill	855 to 875
Wolf Creek	910 to 829 to 825 to 800
Woolsey's Flat	910
Wilcox Ravine	845 to 855
You Bet (blue gravel)	890 to 919
You Bet (red gravel)	907 to 984
Yankee Hill	917

Placer County.

Antelope Ravine	770
Antone	900 to 910
Auburn Ravine	810
Bath	870 to 910
Bear River	900 to 910 to 930
Bear Valley	914
Blue Gulch	925
Blue Lead	930 to 935 to 940 to 944
Bird's Flat	893
Bird Valley	830 to 890
Brushy Cañon	925
Burnt Flat	865 to 870
Cañon Creek	950
Canada Hill	900 to 910
Cedar Company	965
Colfax Ravine	900
Damascus	900 to 890
Deadwood	930 to 945
Devil's Basin	945
Doten's Bar	870
Doty's Flat	750
Doty's Ravine	750
Dutch Ravine	810
Dutch Flat	934 to 950 to 940 to 970
Dutch Flat Ravine	930
El Dorado Cañon	870 to 935
Elizabethtown	860
Forest Hill	880 to 890
Gold Run	950 to 975
Green Valley	920
Grizzly Flat	905
Humbug Cañon	890 to 894
Huyck Company	945
Illinoistown	794
Indiana Hill	925
Iowa Hill	900
Last Chance	915 to 920
Ladies' Cañon	750 to 870
Long Cañon	930
Lost Camp	940
Mad Cañon	870
Michigan Bluff	940 to 970
Michigan Flat	925 to 970
Minna Flat	890
Middle Fork of American	870 to 880 to 890
Millertown	800
Miller's Defeat	916
Miners' Ravine	760
Nary Red	916 to 935
Nevada Company	945
North Fork of American	870 to 875 to 910
North Ravine	790
Ophir	740
Paradise	830 to 840
Pine Flat	800
Red Hill	960 to 970
Roach Hill	918
Rock Creek	910
Rich Flat	915
Rock Spring	690
Secret Cañon	900 to 910
Secret Town	825 to 860
Secret Ravine	800
Squires' Cañon	960 to 965
Taylor Company	965
Van Cliff	900 to 910
Virginiatown	775
Yankee Jim	900

Plumas County.

Jamison	860
Laporte	940 to 945
Onion Valley	900
Poorman's Creek	860 to 880

Sierra County.

Alleghany	900
American Hill	935 to 950
Bald Mountain	915 to 956
Balsam Flat	880
Cañon Creek	880
Cedar Grove	930
Chaparral Hill	905
Chipps' Flat	880
City of Six	900
Chandlerville	920 to 940
Cold Cañon	918
Craycroft	880
Deadwood	840
Downieville	885
Eureka	840 to 905
Excelsior	905
Feather River	870
Fir Cap (Fir Gap)	828
Forest City	900
French Ravine	800

Gibsonville	900 to 936
Hepsidam	900
Hopkins' Creek	915
Howland Flat	900 to 909 to 919
Kanaka Creek	860
Ladies' Cañon	884
Middle Yuba	875
Monte Christo	905
Minnesota	880
Near Sierra Buttes	920
Nebraska (blue lead)	935
Nelson	887 to 906
Oregon Creek	830
Poker Flat	890
Pine Grove	920
Potosi	912 to 919
Poorman	910
Port Wine	935
Ravines near Laporte	900
Richmond Hill	910
Rock Creek	900
Sawpit Flat	910
Slate Creek	900 to 880
Smith's Flat	825
Spanish Ranch	945
St. Louis	900 to 925
Sweet Oil Diggings	875
Union Company	870
Washington Hill	906
Wet Ravine	825
Whisky Diggings	905
Young America Flat	800 to 820

Tuolumne County.

American Camp	850
Cooper's Flat	735 to 825
Columbia	930 to 950
Golden Rule	800
Jamestown	890 to 900 to 815 to 820
Montezuma	900
Poverty Hill	890 to 900
Shaw's Flat	927 to 930
Springfield	930 to 960
Sonora	878
Somerville	780
Sugar Pine	900 to 920
Rawhide Ranch	850

Yuba County.

Brownsville	890
Mooney Flat	900 to 940
Ousely's Bar	950
Parks' Bar	960
Timbuctoo	930 to 962

QUARTZ MINES.

Amador County.

Coney	878
Fogus	780
Hinckley	800
Jackson	810
No. 1. Jones at American Camp (with lead)	540
No. 2. Jones at American Camp	750
Kelly & Stevenson	820 to 810
Keystone	830
Oneida	830
Paugh's	810 to 830
Plymouth	770 to 772 to 840
Seaton	730
Shanghai	870
Spring Hill	820 to 824
Tellurium	750

Butte County.

Mount Hope	860
Nesbit	890

Calaveras County.

Angel Quartz Company	900
Bovee	908
Dr. Hill	900
French Gulch	803
Flanigan	910
Isabel	875 to 880
Morgan	910
Quail Hill	560
Stickles	885
Union	904 to 908
Woodhouse	820

El Dorado County.

Clipper Hill	900
Dane's	800
Eagle	650
Gray's	895
Georgia Slide	900
Hermitage Ranch	887
Independence	796
Knox	650
Steeley	650

Mariposa County.

Bear Creek	877
Goodwin	895
Hite's Cove	814
Hornitos Creek	650 to 660
Louisiana	652
Mariposa	700 to 800
Mariposa (Josephine lode)	869 to 875
Princeton (Josephine lode)	750 to 820
Pine Tree (Josephine lode)	780 to 790
Ryerson (Josephine lode)	918
Wright	738

Nevada County.

Allison Ranch	850 to 860
Bear River	803
Ben. Franklin	808
Cambridge	820
Canada Hill	730
Eureka	850 to 852
Empire	800
East End	846 to 856
Forest Spring	810
Gaston Ridge	819
Gold Hill	850 to 860 to 875
Goodyear Company	840
Illinois	854
Ione	815
Jim	827
Lucky	817
Merrimac	817
Murphy	800
Nevada Company	830 to 859
North Star	852
Osborne Hill	760 to 775
Potosi	816
Pacific	845
Rattlesnake	800
Rocky Bar	853

Shanghai	860
Shamrock	799
Sneath & Clay	823
Union Hill	822
Upham	821
Ural	802 to 807
Union Jack	811 to 823
Washington	860
Whigham	806
Wyoming	798 to 819

Placer County.

American Bar	860
Ophir	690
Rugh	630
Schnabel's	688

Sierra County.

American Hill	877 to 886
Eureka	875
Independence	866
Ironside	900
Keystone	933
Mammoth	870
Oak Flat	780 to 800
Reis	860
Rough and Ready	900
Sierra Buttes	865
Union	823

Tuolumne County.

Big Basin	600 to 785
Bald Mountain	930 to 950
Heslep	775
Mount Vernon	860 to 894
Reist	790
Table Mountain	908 to 950
Rawhide	830
Talc Lode	600 to 785

Yuba County.

Dannenbroge	860 to 900
Jefferson	840
Pennsylvania	840
Sweet Vengeance	880

TABLE SHOWING YIELD PER TON OF CALIFORNIA QUARTZ MINES.

Compiled from notes made by John S. Hittell:

Amador County.

Bunker Hill	$10 00
Coney	$13 to 13 50
Craft's	15 00
Golden Eagle	15 00
Hazard	12 00
Hinckley	12 00
Kelly & Co.	14 00
Mitchell	60 00
Oneida	17 00
Paugh's	10 00
Pioneer	40 00
Plymouth	8 00
Railroad	15 00
Seaton	8 00
Shanghai	32 00
Sirocco	15 00
Spring Hill	8 00
Van Tromp	100 00
Vaughn	10 00
Webster	7 00

Butte County.

Bateman	$30 to $40 00
Forbestown	20 00
Genesee	18 00
Mexican	10 00
Rare Ripe	18 00
Round Valley	22 00
Shakespeare	10 00
Spring Valley	$10 to 18 00

Calaveras County.

Albion	$6 00
Angel Q. M. Company	$8 to 15 00
Bovee	$9 to 10 00
Badger and Eureka	$12 to 15 00
Chaparral Tunnel	240 00
Crispin	20 00
Ella	8 00
Fisher's	7 00
Grizzly	$8 to 10 00
Harris	5 00
Mina Rica	$35 00
Morris	50 00
Mosquito	7 00
Reserve	100 00
Rocky Bar	25 00
Skull Company	$30 to 35 00
Santa Cruz	300 00
South Carolina Co.	$10 to 12 00
Thorpe's	10 00
Union Mine	23 00
Woodhouse	$10 to 14 00

El Dorado County.

Alpine	$72 00
Clipper	15 00
Collins	15 00
Cosumnes	11 00
Eppley	50 00
Independence	30 00
McDowell	3 50
Montezuma	10 00
Manning	30 00
Pacific	15 00
Persevere	15 00
Pocahontas	15 00
Plymouth	18 00
Rosecrans	12 00
Shepard	25 00
Stillwagen	25 00
Woodside	30 00

Mariposa County.

Adelaide	$8 00
Black	40 00
Benton Mills	29 00
Calico	20 00
Cherokee	35 00
Coward	40 00
Crown Lead	9 00
Derrick	$20 to 30 00
Epperson	$9 to 13 00
Ferguson	25 00
Flanigan	35 00

Green Gulch	$38 00
Goodwin	50 00
Hite's Cove	$25 to 30 00
Louisiana	$6 to 8 00
Mariposa	9 00
Marble Springs	25 00
Maxwell Creek	$8 to 9 00
McKenzie	20 00
Mount Ophir	$8 to 12 00
New Britain	20 00
Nonpariel	$13 to 30 00
Princeton	$16 to 18 00
Potts	$50 to 60 00
Sherman	$60 to 100 00

Nevada County.

Gold Hill and Rocky Bar	$80 00

Placer County.

Empire	$8 00
Golden Rule	12 00
Green Emigrant	10 00
Schnabel's	6 00
Stewart's Flat Mining Company	15 00
Wells	12 00

Plumas County.

Bullfrog	$8 00
Callahan's	12 00
Crescent	$12 to 15 00
Eureka Plumas	12 00
Indian Valley	18 00
Premium	19 00
Plumas Mill	$8 to 10 00

Sierra County.

Independence	$10 00
Keystone	17 00
Oak Flat	$15 to 23 00
Primrose	15 00
Reis	16 00

Tuolumne County.

App.	$15 00
Anthrac	14 00
Argentum	125 00
Big Basin	$40 to 50 00
Burns	15 00
Carson Creek (portion of vein 60 ounces silver per ton)	$7 to 8 00
Columbia	11 00
Davidson	40 00
Eagle	$18 to 30 00
Golden Rule	$10 to 12 00
Gillis	25 00
Heslep	10 00
Kimball (extension)	10 00
Mount Vernon	100 00
Mooney & Co.	4 75
Mother lode at Rawhide	$8 to 70 00
Old Gelsen mine	50 00
Rawhide	$7 to 8 00
Small mine, Knight's Creek	50 00
Starr King	15 00
Shawmut	18 00
Summit Pass	8 00
Summit	$10 to 80 00
Talc Lode	$5 to 6 00

Yuba County.

Deadwood	$30 00
Dannenbroge	$15 to 20 00
Honeycomb	7 00
Pennsylvania	$15 to 20 00
Polecat	12 00
Rattlesnake	18 00

67. GRAPHITE. Etym. "*I Write*" (Greek). Plumbago, Black Lead, etc.

Graphite, when pure, consists of carbon; but it is comparatively seldom found pure, being generally mixed with earthy matters, from which it can be freed by mechanical means. The operation is, however, expensive and not always satisfactory, for which reason low grade graphite has but little value. There are a number of localities in the world (Cumberland, England, Ural Mountains, Russia, Ceylon, Madagascar, and elsewhere), where a fair quality is obtained in abundance, from which the market is supplied. No graphite of good quality has been found in California, although an inferior article is not uncommon in the State. Molybdenite is frequently mistaken for it.

The following constitute the principal places where graphite has been found in California: One mile north of the town of Sonora, and at Gold Springs, in Tuolumne County; near Fort Tejon, Kern County; on the border of Tomales Bay, in the Coast Range; near Summit City, Alpine County; and at various localities in Sonoma, Marin, Plumas, and Sierra Counties. A heavy deposit of this mineral is said to have been discovered quite recently at Tejunga, twenty-five miles from the City of Los Angeles, and twelve miles from the line of the Southern Pacific Railroad; and another at Borer Hill, in the northeastern part of Fresno County. With so many discoveries reported, but little graphite has yet been mined in this State. Only on the Sonora deposit has much work been done, and from this alone has even so much as a few tons of the mineral been extracted; this neglect being due to a variety of causes, such as the impure character of the mineral, cost of mining and transportation to market, etc. This Sonora deposit, which was discovered in 1853, was afterwards, under the name of the Eureka Plumbago mine, worked in an inefficient and limited way for a number of years, about 1,000 tons of plumbago having been extracted altogether. There being little demand for the article in California, nearly the whole of it was shipped to England, France, and Germany, and there sold at an average price of $100 per ton, which it was at the time claimed afforded a net profit of $50 per ton. The cost per ton of production and marketing here was about as follows: Mining and preparing the material, $5; sacks, $2; freight to Stockton, $9; freight to San Francisco, $1 50; freight to Liverpool, $14; commissions, storage, insurance, etc., $18 50. Not for the past fifteen years has anything been done at this mine; pretty good evidence that operations on it could not be made to pay. The trouble consisted, no doubt, in the difficulty of obtaining here a merchantable article without incurring too much expense, this mine containing a large mass of low grade, with only a small per cent of pure mineral. From the accounts given of them, several of the other deposits found in the State may be expected to yield much larger quantities of marketable graphite than this mine near Sonora, and as some of them are located near railroads, they will probably meet with early and profitable exploitation.

The principal uses of graphite are the manufacture of the so called lead pencils; as an anti-friction substance; stove polish; the manufacture of crucibles; and as a pigment, which is claimed to be very durable. This paint is specially useful as a protection for smoke stacks against acid fumes. For the three latter purposes, the graphite refined from the impure mineral serves very well, and it is probable that for such purposes the California deposits will in the future be largely utilized. According to Blake, it is found twenty miles above Big Tree Grove, in crystalline scales (probably molybdenite); and at Knight's Valley, Sonoma County. The following localities are represented in the State Museum: (929) is from Sonora, Tuolumne County; (1895) from Guerneville, Sonoma County; (3746) from near Pine Flat, Sonoma County.

Gray Copper—see Tetrahedrite.

68. GROSSULARITE. Etym. *Gooseberry* (Latin).

Lime garnet is quite abundant in California, especially in the southern counties, where it has often been mistaken for tin by Cornish miners who have seen it, and several tin excitements have had their origin in this mistake. It is found also with copper ore in the Roger's claim, Hope Valley, El Dorado County (Dana), and, as in the specimen No. 2190, in the State Museum, with datholite, near San Carlos, Inyo County.

69. GYPSUM. Ancient name—Alabaster, Selenite, Satin Spar, Plaster of Paris.

This mineral is a hydrous sulphate of lime. ($CaO, SO_3+2\ HO$.)

Sulphuric acid	46.5
Lime	32.6
Water	20.9
	100.0

H=1.5—2. Sp. gr.=2.314—2.328. Color: white, gray, pink, yellow, blue, and sometimes almost black; transparent to opaque. When it is fine grained and compact it is called Alabaster, from "Alabaster" or "Alabastra," the ancient name of a box for holding perfumes and ointments; whether the box was named from the stone, or the reverse, is uncertain. Alabestrites, from which these boxes were made, was aragonite, or stalagmite, probably the variety described under the head of onyx marble. Gypsum in transparent plates, like mica, is called *selenite*, from the Latin "selenitis," the moon; the word being of Greek derivation: and when fibrous *satin-spar*.

Gypsum is employed in the arts as a cement (Plaster of Paris), and as a fertilizer. For the latter purpose it must in time be extensively used on the lands of California, now being rapidly exhausted. The farmers will some day awake to the fact that they cannot continue to harvest crop after crop from their lands without returning something to them, and the day is not far distant when fertilizers of all kinds will be used and not wasted as at present. Plaster of Paris is made by calcining pulverized gypsum at a low heat in iron kettles, by which the water is driven off. When so prepared, it has the remarkable and useful property of hardening again when water is added. When calcined with alum a harder cement is formed, "Keene's." When borax takes the place of alum it forms "Parian;" when pearl ash, "Martin's cement." Stucco is Plaster of Paris mixed with weak glue. Plaster of Paris is used with lime for hard finish plastering, and for making imitation marbles, for filling in between floors, and in other useful ways.

In the manufacture of bay salt, extensively produced on the shores of San Francisco Bay, and described in the second annual report of the State Mineralogist, sulphate of lime (gypsum) deposits from the sea water in the tanks. This deposit at the works of the Union Pacific Salt Company is estimated by Mr. Winegar to be over 1,000 tons per year. This could be gathered, ground, and washed to remove the salt, in which condition it would be valuable to sow on the lands as a manure. It is a question if there is another locality where so large a quantity of a valuable fertilizer would remain so long unused. At the other salt works the same material forms in proportion to the quantity of salt produced. The following California localities of gypsum are given by Blake:

Los Angeles County, in the Great Basin, near the entrance to the Soledad or "New Pass." San Diego County, along the banks of Carizzo Creek, and on the slope of the Desert. Tulare County, at the vein of stibnite in crystals. Nevada County, near the Truckee Pass, in beautiful stellar radiations, from half of an inch to three inches in diameter—(Cabinet of C. W. Smith, Grass Valley). Fine specimens are brought from the Ojai Ranch, Ventura County. It is found also in the mountains of the Arroyo Grande, San Luis Obispo County. The following localities are represented in the State Museum: (362.) Lockwood Creek, Los Angeles County. (667.) Monterey County. (2268.) Near Breckenridge, Kern County. (3726.) Near Hill's Ferry, Stanislaus County. (5018.) Posa Creek, Kern County.

ALABASTER.

Arroyo Grande, San Luis Obispo County. Los Angeles County (Blake). Point Sal, Santa Barbara County (6051).

SELENITE.

In large slabs, Soledad Cañon, Los Angeles County.
(354.) Lockwood Creek, Ventura County.
(799.) Santa Barbara County.
(957.) Near Dos Palmas Station, Southern Pacific Railroad, San Diego County.
(1260.) Robinson's Ranch, Lake County.
(1721.) In large slabs, near Susanville, Lassen County.
(2890.) Buena Vista, Kern County.
(3699.) Colorado Desert, San Diego County, five miles west of Volcano Station, Southern Pacific Railroad.
(4089.) San Emidio antimony mine, Kern County.
(4465.) Bear Valley, Mariposa County.
(4464.) Near Modesto, Stanislaus County.
(4672.) Calico, San Bernardino County.
(4765.) Near Gilroy, Santa Clara County.

SATIN SPAR.

(1847.) White River, Tulare County.
(4361.) San Bernardino County.

The deposit in Santa Barbara County (6051), represented to be of great excellence and very extensive, possesses the further advantage of being located within two miles of Point Sal, a shipping station on the coast for this portion of the county. This gypsum is of the white or Nova Scotia variety, being a kind well suited for making plaster of Paris, and which is said to occur abundantly at only a few other points in the United States.

Lucas & Company, proprietors of the Golden Gate Plaster Mill, in San Francisco, having leased this Point Sal gypsum bed for a long term of years, are now working the same actively, over one thousand tons of the raw material having been sent to their mill and manufactured into plaster of Paris. The article made by this firm is preferred to the best imported; plaster, like all these calcareous products, owing to the readiness with which it absorbs moisture, being greatly deteriorated by a long sea voyage. Formerly all the plaster consumed on this coast was imported, but since the Golden Gate Mill commenced operations, about ten years ago, importations have fallen off heavily, and will probably be still further diminished hereafter.

The imports of plaster of Paris at San Francisco have been as follows:

BARRELS AND SACKS.

Year	Barrels and sacks	Year	Barrels and sacks
1874	19,176	1879	5,400
1875	22,782	1880	3,200
1876	14,918	1881	5,850
1877	14,487	1882	4,777
1878	11,038		

Of late, prices have been low, being at present quoted at $2 50 and $3 per barrel.

The Santa Barbara deposit, above alluded to, if of the extent and kind represented by the local press, would seem to be the most important gypsum find that has yet occurred in California, being of easy access and located in a section of country where this mineral will be likely to come into large use as a fertilizer. Gypsum, found at a point about ten miles from Los Angeles, has been taken to that city, ground in the mill there, and on being applied to the land showed excellent fertilizing properties. The gypsum beds of Kern County extend along the foothills from Caliente to Long Tom, a distance of about thirty miles. Though occurring at intervals along so great a linear extent not much is known as to the quantity of the mineral here, no work having been done on these beds. Heavy beds of gypsum are reported in San Bernardino County at a point forty miles south from the county seat and fifteen from the line of the Southern Pacific Railroad.

For a number of years prior to the Santa Barbara discovery, the mills in this city procured their supply of gypsum for making plaster of Paris from Lower California, where an article suitable for this purpose can be readily obtained, ships being able to come within a short distance of the deposit.

70. HALITE. Etym. *Salt* (Greek). Common Salt.

The manufacture of salt was described in a special paper in the second annual report of the State Mineralogist. Since that report was published, several new salt springs have been discovered, and in sinking wells for petroleum, salt water frequently rises. The following is an analysis of a sample of water, No. 1936, from Placer County, near the Clipper Gap iron mines:

Solid matter, per gallon .... 17.65 grains

Silica, per cent	.58	By weight, grains	.102
Sulphate of lime, per cent	.53	By weight, grains	.093
Carbonate of lime, per cent	53.55	By weight, grains	9.450
Chloride of sodium (salt), per cent	45.34	By weight, grains	8.005
	100.00		17.650

Magnesia, oxide of iron, and alumina, traces.

The following is a statement of the production of salt in Alameda County, since the publication of the second annual report:

1882, about 35,000 tons; 1883, about 33,000 tons, most of which is still on hand at the works—at least 35,000 tons—some having been left over from 1882. No new companies have been started since 1882.

A. B. WINEGAR,
Union Pacific Salt Company.

71. HEMATITE. Etym. *Blood* (Greek). Hæmatitis, Specular Iron, Micaceous Iron, Red Hematite, Sesquioxide of Iron. (Fe_2, O_3.)

Iron	70
Oxygen	30
	100

The name comes from an early historical period, being mentioned by Theophrastus, Pliny, and other ancient writers. Color and streak, bright red; translucent in thin fragments. B. B. on ch., infusible, but becomes magnetic; soluble in muriatic acid; these tests serve to distinguish it. It is a valuable iron ore, and is rather common in California, with other ores of iron.

CALIFORNIA LOCALITIES.

The variety, specular iron, occurs at Mumford's Hill, Plumas County (Edman); in large masses at Light's Cañon, Plumas County (Blake); near Shasta City, Shasta County (Dana). It is represented in the State Museum by the following specimens:

(87.) Ione Valley, Amador County. (1606.) (red) Owens' River Valley, Inyo County. (1860.) Clipper Gap iron mine, Placer County. (1861.) (ochrous) Clipper Gap iron mine, Placer County. (1896.) Kelsey Tunnel, fourteen miles southeast of Crescent City, Del Norte County. (1937.) Red Hill, Placer County. (2336.) Alameda County. (2833.) (earthy) Monitor, Alpine County. (2285.) (micaceous) Feather River, near Oroville, Butte County. (3367.) Near Campo Seco, Calaveras County. (3652, 3760.) San Andreas, Calaveras County. (3761.) Near St. Helena, Napa County. (3766.) Big Trees, Calaveras County. (3773.) Nevada County. (4356.) Diamond Springs, El Dorado County. (4652, 4987.) Near Jackson, Amador County.

72. HESSITE. Etym. *Hess*, Russian chemist. Telluride of Silver.

A single specimen was obtained in 1854, near Georgetown, El Dorado County. It had been washed out from the gold drift, and the parent vein has never been found (Blake).

HORNBLENDE—see Amphibole.

HORNSILVER—see Cerargyrite.

HORSEFLESH COPPER ORE—see Bornite.

HYALITE—see Opal.

73. HYDROMAGNESITE.

A mineral, supposed to be hydromagnesite (no analysis), is found in the serpentines on the peninsula of San Francisco, and elsewhere in the State. It is represented by specimen No. 1320, in the State Museum.

ICELAND SPAR—see Calcite.

IDOCRASE—see Vesuvianite.

IDRIALITE—see Petroleum.

ILMENITE—see Menaccanite.

IODIDE OF MERCURY—see Coccinite.

IONITE—see Mineral Coal.

74. IODINE. Etym. *Violet* (Greek).

Iodine is one of the elements resembling chlorine and bromine. It was discovered by accident in 1812 by M. de Courtois, while manufacturing saltpeter in Paris. In decomposing the ashes of seaweed to obtain soda he discovered this substance, which corroded the metallic vessels in which the operation was conducted. The chemists Clement and Desormes, who first examined it, found that at a low temperature it became a violet colored gas; from this they named it "*Iodine.*" Iodine, like chlorine and bromine, has a strong affinity for silver; advantage was taken of this in the early history of photography. So combined, it is found in nature as iodyrite, or iodide of silver, discovered by Vaquelin soon after the element became known.

Iodine exists in many marine plants and animals, in mineral waters, and in a few minerals, notably with nitrate of soda and salt. It is largely manufactured in Scotland from the seaweed abundant on the Scotch and Irish coasts. The weeds are thrown up on the beach and dried in the sun, after which they are burned, forming kelp. This is lixiviated and the solution concentrated by evaporation, the useful salts which crystallize out being removed from time to time. The dark colored liquors which remain are acidulated with sulphuric acid, and then heated with bin-oxide of manganese, in a leaden retort set in brick and connected with a series of condensers, in which the sublimed iodine collects. The apparatus may be found figured in "Graham's Elements of Chemistry," London, 1850, vol. 1, fol. 492, and in other works on technical chemistry. This process is mentioned here because there is reason to think that iodine is more abundant on the Pacific Coast than is generally supposed. Dr. Trask found free iodine and bromine in the serpentine rocks at Point Lobos, San Francisco. ("Report on the Geology of the Coast Mountains, etc., J. B. Trask, State Geologist, 1854," fols. 26 and 92.) About seventeen years ago I made an analysis of mineral water containing a large quantity of iodine. The sample was furnished by Mr. Fargo, of San Francisco, who has since informed me that the spring from which it was taken was at the entrance of Grizzly Cañon, Lake County, five or six miles from Wilbur Springs. In a letter by Dr. John A. Veatch, quoted in the third annual report of the State Mineralogist, 1883, fol. 17, he writes: "Nothing of much importance presented itself until reaching the saline district, about eighty miles south of Red Bluff. It is on one of the branches of Stony Creek. Valuable salt springs exist here. The waters contain the borates in minute quantities, and one spring was remarkable for the enormous proportion of iodine salts held in solution." I have long suspected that the mother liquors of the borax works in California and Nevada contained iodine, and have it still in mind to examine them in the near future. The recent discovery of nitrate of soda in California and Nevada adds to the likelihood of finding iodine. Mineral water containing iodine, but no objectionable minerals, must of necessity constitute a valuable medicinal agent in the hands of medical men familiar with its analysis. And here it is proper to call attention to the importance of having an official guide-book to the mineral springs of the State, containing full and careful analyses of all the known springs, made in the laboratory of a State institution, and at the public expense, the accuracy of which could not be questioned, as those made in the interest of the proprietors of the springs sometimes are.

Iodine is a valuable substance, being much used in the arts, and indispensable in medicine; and as it brings a high price, its production in the State is a matter of importance.

75. IRIDIUM. Etym. *Rainbow* (Latin).

This is one of the metals of the platinum group, and is never found except in association with the others. The metals of the "platinum group" are platinum, iridium, rhodium, osmium, and palladium. These metals are found in placers like gold, and generally if not invariably associated with that metal, and frequently with copper, magnetite, zircons, and sand. The proportions of the platinum metals vary among themselves, platinum grains being in the majority. Iridium, like the others of the group, is invariably found in the metallic state, always alloyed with platinum or osmium, as platiniridium, and iridosmine or osmiridium in flat metallic scales, tin-white, and infusible. H=67, sp. gr.=19.3—21.12, only slightly malleable. A specimen from California gave the following analysis (Dana):

Iridium	53.50
Rhodium	2.60
Ruthenium	0.50
Osmium	43.40
	100.00

Iridium was discovered and made known by Smithson Tennant in 1804. In dissolving native platinum in aqua regia a residue remained, which proved to be a new metal, iridium and osmium. Iridium being very hard is used in the arts for a number of purposes for which it is specially fitted; such as points for gold pens, called diamond points, for which purpose it must be very carefully selected. The ore is first spread on paper and the iron removed with a magnet; it is then sifted to remove fine dust, and subjected to the action of quicksilver to remove gold, then boiled with acids, washed, and dried. From what remains, pieces are picked out with forceps by hand, under a magnifying glass; only those suitable for the purpose are selected. This must be done by a person of experience. The portion rejected is then treated by fusion and the action of acids, by which platinum is separated, and it is then ready for other uses, such as the manufacture of plates for drawing steel and gold wire, knife edges for chemical balances, hypodermic needles, electric lighting, bushing for the touchholes of heavy ordnance, etc.

Iridium has been found with gold and platinum in all the stream washings or placer mines of California—also in the auriferous beach sands. As not much effort has ever been made by the miners to save it, the quantity collected in this State has not been large. During the earlier stages of gold washing, when operations were prosecuted on a more extended scale, the miners finding this troublesome stuff in their sluices, where its great weight had retained it with the gold, were at much pains to separate it from the latter, after which, being ignorant of its value, the most of it was thrown away. Afterwards, when the miners found out what it was, they began to save this metal, and small lots, finding their way to San Francisco, were sold at such prices as happened to be offered for it, there being no regular purchasers in this market. For a number of years considerable quantities of iridium continued to be sent to this city, some of it gathered in this State and some coming from Oregon. Latterly, however, the business of collecting it seems to have entirely ceased, but for what reason is not quite apparent, as placer operations are still conducted in California on a large scale. Whether the prices paid for the metal here were so little satisfactory that the miners did not care to further look after it, or whether they no longer find it in their sluices, we are not advised; the latter, however, can hardly be the case.

Of large quantities of iridium collected very little is found of the size and shape that adapts it for the special uses that render such small portion extremely valuable. For instance, hardly one per cent of any average lot will prove suitable for pointing gold pens, or for the other delicate work for which the metal is used. Selecting these particles, dealers pay for them large prices, perhaps twenty, thirty, or even fifty dollars per troy ounce; whereas, for the rejected portions, they will pay scarcely more than three or four dollars per ounce, and for a very poor quality not one quarter as much. But, even at the least price paid for this metal, it might be worth while for our miners to look after it, if the placers continue to yield it, as it can be recovered and saved, where gravel washing is going on, with very little extra labor. The cheaper and lower grade metal is used for making iridium oxide, a black pigment employed for decorating fine porcelain. It is also useful, and perhaps essential, in the production of electric lights, Edison having, it is said, sent to California for all that could here be obtained of that grade.

In melting gold in the United States Mint in San Francisco, and in the bullion refineries of the State, much iridium was collected which rose to the surface of the melted gold, and was skimmed off with the flux or dross. At the San Francisco Assaying and Refining Works, under the management of Kellogg & Hewston, large quantities were so collected. The principal localities in the State where it has been found will be given under the head of Platinum.

IRIDOSMINE—see Iridium and Platinum.

IRON GARNET—see Garnet.

76. IRON AND IRON ORES. See also Hematite, Limonite, and Magnetite.

Of all the metals known to man, iron is the most generally useful. It has been said that the civilization of a country may be measured by the quantity of iron produced and consumed. While iron is the most useful of metals, it is at the same time the most widely distributed. Although seldom found in a metallic state in nature, it seems to permeate the earth's crust, and appears in many forms. It is one of the constituents of the granites which are considered to be almost the foundation of the earth. It is abundant as an ingredient in the volcanic rocks, and still more so in mountain masses, beds, stratified deposits, eruptive masses, etc., at many localities on the surface of the earth. It is found in mineral waters, and it circulates in solution in the veins and tissues of plants and animals.

Native iron being extremely rare, being almost wholly, as far as known, of meteoric origin, we must look to the ores of that metal for our material. These ores occur in rocks of all ages, and are abundant in California at a number of known localities. There are two distinct classes of iron ores that are sought by the smelter: those known as *spathic*, the most important of which is *siderite or carbonate of iron*, and the oxidized ores known as *magnetite, hematite, and limonite.* The latter are the most common in the State. Iron occurs in other forms, combined to a greater or less extent with other substances and metals, as *franklinite, pyrites, titaniferous iron, chrome-iron, magnetic sands*, etc., which have their uses in the arts, but which are not suitable for the production of the metal.

Long ages passed, after man appeared on the earth, before the use of iron was discovered. That metal has so strong an affinity for oxygen that it does not long remain in a metallic state, and there is nothing in the appearance of the rusty looking oxides that would indicate to the uneducated mind that a valuable metal could be extracted from them. The progress was gradual, as shown by the study of primitive man—from the use of rude stone implements to those of polished stone, then to the era of bronze and copper, followed in comparatively modern times by the use of iron. There can be no doubt that gold and copper were in common use long before iron was known. When this metal was first introduced it was, no doubt, far more precious than gold. It represented excessive labor, while gold and copper were found in a metallic state, and were easily wrought. The relative value of these metals in early times is illustrated by swords and knives of gold, the edges only being of iron, found in ancient mounds in Denmark, with older implements of the stone age, now preserved in the Museum of Copenhagen.

Manifold are the uses to which iron may be put, from the construction of the hull of a war ship to the tiniest screw in a lady's watch. It can be rolled into sheets as thin as paper, drawn into the finest wire, twisted and woven, rolled into bars that can be tied into knots without breaking. It can be forged, welded, and turned into desired shapes in lathes. It takes the polish of a mirror, and it can be melted like water and cast in quantities weighing many tons. Its salts, and compounds with other substances, have many uses in the arts; that of war being almost dependent upon iron, which has led to the naming many of its salts after Mars, the war god of the ancients. In short, this metal has become almost indispensable to mankind.

There are three kinds of iron in common use: crude cast or pig iron, malleable or bar iron, and steel. The different states of the iron depend principally on the quantity of carbon they contain. Cast iron has the most, and bar iron the least. All iron was formerly smelted by the heat generated by the combustion of wood charcoal. In sixteen hundred and eleven it was discovered that mineral or pit coal could be substituted for charcoal, which revolutionized the iron manufacture. It was not, however, successfully used until one hundred and twenty-four years later. In fifteen hundred and eighty-four the attention of the British Government was called to the threatened destruction of the forests by the use of the wood for making charcoal for iron furnaces. An Act of Parliament was passed restricting the use of wood for that purpose.

In countries where forest trees are abundant, charcoal is still extensively used for the production of crude iron. In California, for the time being, this fuel must be used, unless our extensive deposits of petroleum can be utilized for that purpose. In early times rude and temporary furnaces were used for smelting, but in modern days they have been improved until they have become models of human ingenuity and skill. They now represent large capital. They are costly and complex, and, at the same time, nearly perfect in all their parts, the result of consecutive years of experience and study.

As molten iron comes from the blast furnace, it is formed into rude ingots known as "*pigs*," or "*pig iron*." In this state it is very hard and impure, and can be put only to limited use. To render it malleable is to purify it of certain objectionable substances, such as sulphur, phosphorus, and, more especially, carbon. This is effected by a process called "puddling," by which nearly all the carbon is oxidized. For this purpose a peculiar furnace is used, called, from the operation, a "puddling furnace," in which the crude iron is subjected to the action of heat, and a blast of atmospheric air so managed that the impurities are eliminated, and by a system of stirring, which is very laborious, the soft iron is aggregated into "puddle balls," which are, while in a semi-molten state, hammered, squeezed, or rolled by heavy machinery, until the purified metal becomes homogeneous, and is ready to be drawn into bars or rolled into sheets, as may be required. The same in effect is accomplished in a large way by the Bessemer and other modern processes.

In view of the importance to California of a supply of cheap iron of home production, and as it is desirable that many idle hands should be employed, and that money sent abroad for what could well be produced in the State, should be retained in the land to circulate among our citizens and impart new life to our waning prosperity, it is interesting to know that at least one of the iron deposits of the State is being developed, and the question solved as to whether labor and capital in California can and will coöperate to their mutual advantage, and thus institute important iron interests leading to other industries and manufactures, without which the State must recede rather than advance in prosperity and importance.

The deposit alluded to is in Placer County, near Clipper Gap. The property is in the hands of some of California's most enterprising citizens, and what is very important in a work of such magnitude, is backed by ample capital. The furnace and charcoal ovens were nearly complete when visited by the State Mineralogist in October, 1883. The furnace is constructed on the most modern and approved plans. No expense has been spared to make it as complete and perfect as possible. It is due to the State Geological Survey, conducted by Professor Whitney, to state here that the information which led to this important result is given in the volume on Geology, folio 284, in the following words:

> The ore crops out on a hillside and forms a mass more than thirty feet thick, of which the longitudinal extent is not known, although it is evidently considerable. It is hematite, perhaps mixed with some limonite, and has not yet been analyzed. It appears, however, to be of excellent quality, and is remarkably pure and free from intermixture with rock. With the present prices of fuel and labor, it is not easy to say how soon California will be able to manufacture her own iron; but this locality is, perhaps, more favorably situated than any yet discovered in the State for trying the experiment.

This statement, published eighteen years ago, attracted the attention of a gentleman identified with the iron interests, and led to the enterprise above mentioned.

Samples of ores, limestones, fire clays, and other products have been sent to the State Museum.

IRON ORES AND IRON INDUSTRIES OF CALIFORNIA.

Few countries consume so much iron in proportion to their population as California, notwithstanding this metal has here always commanded extra high prices. This comparatively large consumption grows out of our considerable requirements for mining purposes, and the extent to which we employ this material in building houses, fences, bridges, etc., the high prices we have had to pay for it being due to the fact that our supplies have been imported from distant sources of production, subjecting them to heavy freights and other charges, and compelling dealers to keep large and varied stocks constantly on hand. The destructive fires that so frequently occurred in the early history of the State, led to a free use of iron in the erection of warehouses, stores, and other business structures in cities and larger towns. Additional demands meantime had sprung up for the outfitting of quartz mills, hydraulic plant, etc., the growth of such demands keeping pace with the expansion of these several branches of mining. The substitution of iron pipes for wooden flumes for conveying water across rivers, ravines, and other depressions, has also called for a good deal of iron. Then came the era of railroad construction, adding immensely to other causes of iron absorption, all of which have kept on year by year, undergoing steady enlargement. Besides supplying the Pacific States and Territories, our shops and foundries have turned out great quantities of mining machinery and castings for northwestern Mexico, South and Central America, and British Columbia, with some products in this line for China, Japan, and the islands of the Pacific, the Hawaiian sugar planters having here obtained all their mills, pans, etc. But with requirements so great and the raw material of superior quality scattered abundantly all over the State, not until recently were any well directed and effectual efforts made to manufacture iron in California, the cost of production and fear of foreign competition having deterred even the most enterprising from undertaking it. Although companies had before been formed for producing this metal here, and even taken some preliminary steps in the business, not until 1880 was any purpose of this kind prosecuted to a determinate and successful issue.

QUANTITY AND COST OF IRON USED.

The annual consumption of pig iron on this coast during the past ten years has averaged about fourteen thousand tons, nearly as much more iron in the shape of bars, sheets, and in other forms, having meantime been consumed. The whole of this, with the exception of some little made in Oregon, has, up till the past year, been imported from the eastern States and Europe, mostly from the latter. As the price of pig iron in San Francisco has averaged thirty dollars per ton, and of other kinds at least three times as much, our annual expenditures on account of this item have amounted to $1,350,000—$13,500,000 for the above period, and $35,000,000 or $40,000,000 since the State was founded. That such a drain upon our means should have been suffered to go on so long without any effectual steps being taken to check it, does not argue well for either the thrift or the enterprise of our people; more especially as we possess the raw material in such profusion, as well as the skill and capital requisite for transforming it into useful shapes. What has tended to somewhat relieve the stringency of the iron question here has been the manner in which the extensive rolling mills, erected in San Francisco some fifteen years ago, have since been able to work up the large quantities of old iron that before were either thrown aside as useless, or gathered up and shipped out of the country. Except as affected by the product of these rolling mills, our iron market has, until lately, been without any competitive check. Besides filling orders for iron in cases of emergency, and which could otherwise have been filled only after a long delay, these mills have, in a general way, rendered valuable service to all our other industries. Nevertheless, many of our vital interests have suffered materially through long neglect to produce at home this article of prime necessity.

IRON DEPOSITS OF CALIFORNIA.

As before remarked, beds and veins of iron ores are widely distributed over California, our wealth in this mineral being surpassed by that of few other countries in the world. We have iron fields in the northern, central, and southern counties, and even far out on the deserts that occupy the northeastern and southeastern angles of the State. Iron ore occurs in reefs high up in the Sierra Nevada, and even in notable quantity among the sands along the ocean beach. We do not claim to have mountains of this metal, but in our inexhaustible deposits we have what amounts practically to the same thing. These most useful of all ores are found here, not only at many points and in the greatest profusion, but they are varied in kind and excellent in quality.

IRON ORES IN SHASTA COUNTY.

Throughout the whole tier of our northern counties iron ore, at least on the surface, is met with. The deposits near Crescent City, though not much explored, are apparently extensive, and being close to an eligible shipping point will, no doubt, prove valuable. In Shasta County the ores of this metal are especially abundant. At Iron Mountain, situate a short distance north from the town of Shasta and three miles west of the Sacramento River, exists an extensive bed of iron ore. The deposit crops out on the mountain side, exposing thousands of tons of ore in place, detached masses of great size being also scattered over the surface of the ground adjacent. As there is limestone and timber not far off, this mine could be profitably worked by bringing the ore, fuel, and flux together on the railroad, when it comes to be extended north from Redding, the present terminus, as it soon will be. As this property belongs to men of large means, something will probably be done with it when the railroad is advanced to a point opposite the mine, and from which it will be but three miles distant.

IN SIERRA COUNTY.

At a point twelve miles northeast of Downieville, and at an elevation of 6,200 feet above sea level, occur very extensive deposits of magnetic iron ore, much of which carries from forty to fifty per cent of metal. Touching the character and extent of these deposits, Baron Von Richthofen, in a report upon the same to the owners, remarks as follows: "Your mines consist altogether of magnetic iron ores, the same from which the celebrated Swedish and Russian iron is manufactured. A total amount of ore which may be extracted from the different deposits, by quarrying, I estimate at about 1,400,000 tons—average yield, from forty-five to fifty per cent. Even the removal of the ore next the surface will be the work of a generation." The ore here is represented to be so highly magnetic that it not only attracts the needle, but possesses polarity. This ore is found in three conditions—massive, with a bright steel luster, intermixed with carbonate of lime, and interspersed, in the form of crystals, through chlorite and talcose slate. Thousands of tons of it could be readily mined, and there is plenty of wood and water in the vicinity, but the deposits are so remote, and at present so difficult of access, that they possess little or no commercial value. In working them, nearly eighty miles of wagon transportation, over mountain roads, would have to be made, at a cost of $20, or more, per ton. With a railroad leading to Oroville, or through the mountains to some point on the Central Pacific, the ores here could no doubt be reduced with profit.

BLACK SANDS.

Mixed with the sand on the ocean shore, and extending for long distances both to the north and south of San Francisco, are immense quantities of magnetic iron ore, and which occurring in the form of small particles, constitute a considerable portion of these beach sands. A sample of this sand, taken from a drift near the end of the California Street Railroad, San Francisco, partly concentrated by the wind, contained 5.63 per cent of magnetite. Deposits of a similar character are abundant along the entire coast line of the State. It would, of course, be practicable to separate this ore from the silicious particles with which it is intermixed, by washing, or by the use of magnets, as practiced in some other countries; a process with which we, but for our more available deposits elsewhere, might be tempted to experiment. This magnetic sand makes iron of such superior quality, that it has, in some places, long been employed for that purpose. At Moisic, in Canada, and also in northern New York, this class of ore is extensively smelted after being separated from its associated earthy impurities through the employment of magnets, which perform the work cheaply and quickly. In some cases massive iron ore is pulverized, in order to be cleaned in this manner.

IRON MAKING ON THE PACIFIC COAST.

The California Iron Company was organized in the month of January, 1880, and inaugurated active operations immediately thereafter at Hotaling, Placer County, extensive tracts of iron-producing and timber-bearing lands, at and in the vicinity, having previously been secured. During the first year dams, roads, and bridges, some of them very costly structures, were built; houses, shops, and other out-buildings were put up, and a very complete blast furnace erected. Expensive machinery, including a powerful steam engine, was gotten on the ground and put in place, the propulsive power here employed being steam. Although operations in the field were consigned to seemingly competent hands, the company did not wholly escape the blunders and mishaps which at the outset are so apt to attend ventures of this kind. Some portions of the works, owing perhaps to a lack of proper supervision or planning, proved so defective as to necessitate extensive repairs, and, in some cases, entire rebuilding, within a very short time after they were finished.

But, despite these disasters and troubles, the company succeeded in advancing their works with a good deal of rapidity, getting their furnace, which has a smelting capacity of 25 tons per day, ready for operations in April, 1881. The product of this furnace for that year amounted to 4,260 tons of pig iron—being at the rate of about 500 tons per month for the time it was in blast. The monthly product made by this company during the first half of 1882, and up to the time of their retirement from business, having been somewhat larger than during the preceding year.

The metal made by them has met with ready sale, at extreme prices, having been regarded with great favor by all classes of iron workers and dealers, who prefer it to the best imported brands, it being, in fact, actually worth from $8 to $10 per ton more than the latter. The California Iron Company has been succeeded by

The California Iron and Steel Company.—The new company, though composed mainly of the members of the old, have greatly enlarged the plans and purposes of their predecessors, it being their intention to enter extensively into the manufacture of bar and plate iron, steel rails, etc., as well as carry on the business of making pig metal. To this end they have not only purchased the entire estate of the old company, consisting of their ore beds, furnace, charcoal kilns, wood lands, roads, ditches, etc., but have projected large establishments, some of which are already completed, for carrying out the above objects.

While constructing these new works the company's smelter was kept in full blast up to the time of its partial destruction by fire, in the month of September, 1882, causing a temporary interruption of this branch of their business. With these multiplied and enlarged aims, it will become necessary for the company to increase the capacity of their smelting works, a measure that will meet with early consummation, and which, when carried out, must have the effect to largely curtail the importation of pig metal thereafter. With the product of the Washington and Oregon furnaces it is even probable that the importation of this staple will, in the course of a few years, cease altogether, with the exception of such small quantities of Scotch pig as are required for admixture with our home made iron. Meantime, extensive rolling mills will be put up at some eligible site, probably in the city, or at some point on the Bay of San Francisco, the nail factory that forms a part of this project, being already finished and fully equipped for active service. This establishment, which consists of seven large buildings, having a floor-room of nearly 53,000 square feet, is located in West Oakland, on the line of the Central Pacific Railroad. Besides nails of various kinds, files, tacks, brads, hardware, and many other articles composed of iron will be manufactured here. This company is made up of successful, practical men, each member being peculiarly fitted, by experience and natural qualifications, for looking after some particular branch of the business they have undertaken. They are all men of large wealth, and at the same time active workers—men who earn and execute as well as think and plan. The cash investment made by the members of the California Iron and Steel Company on account of the Clipper Gap estate alone, approximates half a million dollars, their disbursements elsewhere having been very considerable. As their sagacity in divining the future of the State has rarely ever been at fault, these heavy ventures may be construed into omens favorable to our industrial future.

Since the preparation of my second annual report, this industry has undergone some expansion, and, in view of the condition of the business elsewhere, may here be considered to be fairly prosperous.

The California Iron and Steel Company having rebuilt their furnace, and again commenced smelting operations in May, 1883, have since turned out 15,000 tons of pig iron. This iron being of good quality, has met with ready sale on the San Francisco market at current prices, being now extensively used by our foundries, nail works, and other local factories. During the past year this company have increased the capacity of their plant, acquired additional wood lands, and otherwise improved and enlarged their property. The survey of a railroad route between their smelter and Clipper Gap, on the Central Pacific Railroad, indicates a purpose on the part of the company to connect these two points by rail. This enterprise being in the hands of men of large means and progressive ideas, will be kept well up with the times as regards the adoption of the best methods and appliances extant in this line of business. This company employs about three hundred hands—furnacemen, wood choppers, coal burners, teamsters, etc , included.

The Puget Sound and the Oswego Iron Works—The one located at Port Townsend, Washington Territory, and the other near Portland, Oregon, are the only works on the Pacific Coast that make any iron outside of California, except a little produced in Utah. These northern works have lately been running to their full capacity, with the prospect of being kept steadily employed in the future; the business activity incident to the completion of the Northern Pacific Railroad having created a lively demand for iron all through that region. Very little iron from these works was ever shipped to California, and hereafter it is not likely that any at all will be sent to this market.

The Judson Manufacturing Company—Whose establishment is located at West Oakland, have, in pursuance of their original intention, gone on introducing one new industry after another, until half a dozen or more important branches of business are now being carried on there with marked success: Thus, we find grouped together here an extensive foundry, forges, and rolling mills, a file, a nail, a tack, and general hardware factory; a department for making mowing machines and other agricultural implements; spacious wood, paint, and blacksmith shops, the whole supplemented with pattern, drawing, and packing rooms, and the other usual adjuncts of such large and varied plant. The establishment has been superbly equipped, and the enterprise being under an able business and financial administration, promises to become a great success. The tools made here cover a wide range and are of pronounced excellence; and such is the company's confidence in their ability to do good work in every branch of business undertaken by them, that they have furnished their works with machinery for making everything they will hereafter require in the prosecution of their multifarious industries. The iron used by this company consists of the Clipper Gap pig almost exclusively, converting it into blooms in their own forges when bar and other forms of wrought iron are required. This company have in their service over four hundred employés, a portion of them boys, women, and girls; the sum paid out monthly for wages amounting to about $20,000.

The Pacific Iron and Nail Company—Have recently put up in the city of Oakland a rolling mill, a nail factory, and a machine shop, whereat a working force of two hundred and twenty-five hands are steadily employed, at an expense for wages of $12,500 per month. Eight steam engines, with five boilers, supply here the requisite motive power. Of the seventy-one nail machines run, sixty-three are self-feeding, the rest being fed by hand. The preparation of the iron and the manufacture of nails of almost every variety constitute here the principal business carried on, the value of the products turned out being at the rate of $750,000 per year. The company is financially strong, and is doing a prosperous business.

Various other works—For the manufacture of iron, or for the conversion of iron into steel, have been projected in this State, some of these being already in course of construction, one or two nearly completed. A company is putting up an establishment for making steel at the town of Martinez, in Contra Costa County, and have it well advanced, the building being finished and much of the machinery in position. The site of this company's works has been well chosen, both as regards railroad and water transportation. To facilitate shipments by vessels, they will build a wharf at that place. This company will manufacture all kinds of steel by a new process, so cheap and effective, as is claimed, that it will bring to them great advantages. Works are also being put up at the city of Los Angeles for making steel in connection with the manufacture of boilers, bolts, etc., these works being now nearly ready for operations.

The Pacific Rolling Mills Company, of San Francisco, have recently added to their establishment open hearth steel works, with a yearly capacity of 10,000 tons. To the single furnace now in use others will be added, should trade requirements justify. The method employed here is that known as the Siemens-Martin process, by which a very superior steel is produced. In operating this process the company have already achieved a notable success. These rolling mills, the pioneer in this line, having been erected in 1866, remain the most extensive on the coast, the working force here employed, though much reduced just now, amounting in ordinary times to nearly 800 hands. The products of these works include about everything made at similar establishments elsewhere, the principal articles manufactured consisting of steel and T rails, bar and band iron, car and locomotive axles and frames; steamboat shafts, cranks, pistons, etc.; ships' knees, chains, and anchor stocks, with a long list of minor articles, such as spikes, nails, bolts, screws, rivets, etc. Of the 26,000 tons of rails and nail plates turned out in California in 1882, much the greater portion came from these works.

The Union Iron Works Company, another of the pioneer institutions of San Francisco, have during the present year erected on an eligible site at the Potrero new buildings, to which their large business will in a short time be transferred. To each of the capacious buildings here put up will be assigned one or more of the various branches of business carried on by the company; one will serve for the boiler department and the smitheries, another for the iron and brass foundries, a third for the machine shops, etc. These buildings, which cover an average ground area of 50,000 square feet each, are divided into compartments separated from each other by rows of cast iron columns thirty-two feet high. These works have been furnished throughout with the most perfect, powerful, and labor economizing tools, mechanisms, and appliances yet invented. When completed, the establishment will present a model in its way, both as regards equipments, convenience, and sanitary arrangements. A hydraulic lift dock and a marine railway, both nearly finished, form a part of the company's new works; it being their intention to make the building of iron vessels a specialty. This dock has capacity to take up vessels 500 feet long. A spacious wharf, to which ships of the deepest draft can come up, two lines of rails, the one extending from the wharf to the shops and the other connecting the latter with the outside railroad system, constitute other features of the improvements here made.

While the business of producing, casting, rolling, forging, and otherwise manipulating iron has with us, during the past year, shared to some extent the depression common the world over, it has, nevertheless, been pretty active, and in some of its departments tolerably remunerative. The loss sustained by this industry through the partial cessation of hydraulic mining and railroad building has, in some measure, been made up by the preference everywhere given for our mining machinery, for which there have been heavy orders of late from South America, Africa, and other foreign countries. Our importations last year consisted of 23,142 tons of soft, 1,838 tons of white, and 17,780 tons of scrap iron. Importations of white and soft have, during the past five years, been as follows:

Years.	Tons.	Years.	Tons.
1879	9,359	1882	19,993
1880	13,202	1883	24,980
1881	8,600		

A visit was recently made to the Iron Monarch iron mine, near Campo Seco, Calaveras County, No. 3763.

The altitude by aneroid was found to be 620 feet—the locality shows large cropping of limonite. The formation in which it lies seems to be a highly ferruginous sandstone conglomerate, containing bowlders of quartz imbedded. For 2,400 feet northerly and southerly there are here indications of iron ore, with an occasional outcrop. At the north end of the claim there is a hill overlaid with white water-worn quartz bowlders. The whole country seems to have been covered with a drift of quartz bowlders, similar to those in the hydraulic mines at Dutch Flat, Placer County, which lie nearly north, and about sixty-six miles distant. There is no reasonable doubt as to the common origin of these beds or deposits. The country has been denuded irregularly, and the drift left on the summits of hills and table mountains so formed. The Clipper Gap iron mines are similarly situated. Near Messenger's House, Section 6, Township 4 north, Range 11 east, there is a cropping of good limestone suitable for building purposes, flux for iron ore, and lime burning, and also a porphyritic stone similar to that near Clipper Gap, but softer, and a volcanic ash or tufa (5601), which seems to be suitable for building, and of which several houses have been constructed. Of this stone there is a fine specimen in the

State Museum, No. 5601. The following is an analysis by W. D. Johnston:

Silica	72.00
Alumina	26.20
Sesquioxide iron	.60
Lime	.51
	99.31

Of the iron ores five samples were selected to represent gradation from best quality to the poorest; of these samples assays were made by Falkenau & Reese, as follows:

No.	Ferric Oxide.	Per Cent of Iron.
1	80.	56.
2	69.	48.3
3	64.	44.8
4	59.	41.3
5	7.5	5.15

CALIFORNIA IRON ORES IN THE STATE MUSEUM.

(1861.) Hematite, Ochrous—Clipper Gap iron mine, Section 24, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(3585.) Magnetite—Near the New England Mills, Placer County.

(1333.) Magnetite, in dodecahedral crystals—Six miles from Auburn, Placer County.

(3361.) Hematite and Magnetite—Near Crescent Mills, Plumas County.

(3756.) Magnetite—Mohawk Valley, Sierra County.

(1712.) Iron Ore, Oxide—Average from tunnel, Iron Mountain mine, seven miles from Shasta, Shasta County.

(1873.) Magnetite—Iron Mountain, Shasta County.

(20.) Magnetite—McCloud River, Shasta County.

(3422.) Jaspery Iron Ore—Northwest corner of Sonoma County, near Point Arena.

(3759.) Magnetite—San Bernardino County; six miles from water.

(2886.) Magnetite—Eight or nine miles north of Mesquite Station, San Diego County.

(1552.) Limonite or Hematite—Harrington iron mine, San Luis Obispo County, California, four miles southwest of the city of San Luis Obispo, on subdivision of the Rancho Canada de Los Osos, Township 31 south, Ranges 11 and 12 east, Mount Diablo meridian. The ledge has a northwesterly direction, with a dip to the west. Supply of ore seemingly inexhaustible.

(3762.) Iron Ore, Limonite—San Luis Obispo County.

(3774.) Iron Ore, Limonite—Twenty-five miles east of Visalia, Tulare County.

(1519.) Black Sand—Concentration from hydraulic washing, Hopland, Mendocino County.

(3639.) Iron Ore, Magnetite—Solid Iron mine, Indian District, Mono County.

(3768.) Iron Ore, Magnetite—Near Benton, Mono County.

(3757.) Magnetite—Near St. Helena, Napa County.

(3758.) Metallic Iron, reduced from magnetite found near St. Helena, Napa County.

(3773.) Iron Ore, Hematite—Holden Ledge, Township 15 north, Range 7 east, Mount Diablo meridian, Nevada County.

(3767.) Iron Ore, Magnetite—Grass Valley, Nevada County.

(2397.) Limonite Concretions—Forest Hill, Placer County.

(1937.) Hematite—From Red Hill, Section 15, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(1938.) Magnetite—Section 15, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(2848.) Pig of Cast Iron—From the first cast made by the California Iron Company, Sunday, April 23, 1881. Works at Clipper Gap, Placer County.

(4019.) Iron Buttons—Obtained in crucibles, from the Campo Seco iron ore, Calaveras County.

(3760.) Iron Ore, Limonite, and Hematite—San Andreas, Calaveras County.

(4058.) Iron Ore—Said to occur in large quantities one mile northeast of Sperry's hotel, Murphys, Calaveras County. It lies between limestone and slate. Plenty of wood and water.

(1896.) Hematite—Occurs in the rock formation, Kelsey Tunnel, fourteen miles southeast of Crescent City, Del Norte County.

(965.) Magnetite—El Dorado County, California, two miles northwest of Shingle Springs.

(3712.) Siderite, Carbonate of Iron—Tejunga Cañon, Los Angeles County.

(4148.) Iron Ore, Limonite—Near Latrobe, El Dorado County. Vein twenty-two feet wide. Plenty of wood and water. Metallic iron, 55.41 per cent.

(1996.) Magnetite—Coulterville, Mariposa County.

(3717.) Limonite, after Pyrite, perfect crystals—Chowchilla Valley, Mariposa County.

(3005.) Magnetite—Base of Mount Hoffman, south side of the dividing ridge between Mariposa and Tuolumne Counties.

(3006.) Magnetite in gangue—Base of Mount Hoffman.

(1673.) Magnetic Sand with Pyrites—Hydraulic washings, two miles northeast of Jackson, Amador County.

(87.) Hematite—Ione Valley, Amador County.

(3750.) Nodule of Hematite—Near Volcano, Amador County.

(2833.) Earthy Hematite—Monitor, Alpine County.

(2336.) Hematite—Alameda County.

(2788.) Iron Ore, Magnetite—Oroville, Butte County.

(2285.) Micaceous Iron, Hematite—Feather River, near Oroville, Butte County.

(3763.) Iron Ore, Limonite—Iron Monarch mine, Township 4 north, Range 10 east, Mount Diablo meridian, opposite Section 3, in unsurveyed land, two miles in a southerly direction from Campo Seco, Calaveras County.

(3766.) Iron Ore, Hematite—Big Tree iron mine, Calaveras County.

(2455.) Iron Ore, Limonite—Between Jenny Lind and Campo Seco, Calaveras County.

(2745.) Impure Red Ochre—McPherson's claim, Sheep Ranch district, Calaveras County.

(4010.) Yellow Ochre, Limonite—Found in considerable quantities adjoining an iron mine, Campo Seco township, near Campo Seco, Calaveras County. Valuable as a pigment.

(4011.) Burnt Ochre (same as No. 4010)—Near Campo Seco, Calaveras County.

Isinglass—see Mica.

77. JAMESONITE. Named from *Jameson*, Scotch geologist. Sulphide of Antimony, Lead, Iron, Copper, and Zinc.

This mineral is represented in the State Museum by a single specimen, No. 2262, from Mokelumne Hill, Calaveras County.

Jasper—see Quartz.

78. JEFFERISITE. Named from *Jefferis*, mineralogist, of Pennsylvania.

A mineral resembling mica, which is a hydrous silicate of numerous bases, principally alumina, iron, and magnesia. Specimens in the State Museum are (2126), from Susanville, Lassen County, and (4911), from Tulare County.

Kaolin—Kaolinite—see Clay.

79. LABRADORITE. Etym. *Labrador*. Feldspar.

This mineral has been observed in small quantities in street pavement blocks in San Francisco; the exact locality is not known.

80. LEAD AND LEAD ORES. See also Galena, Anglesite, and Cerusite.

Metallic lead has a bluish gray color. It is usually tarnished, in which case it has no luster, but when freshly cut shows a surface highly metallic and brilliant. It is a soft metal, very malleable, easily fusible, and volatile at a white heat. It is scarcely acted upon by hydrochloric acid or dilute sulphuric acid; but moderately dilute nitric acid dissolves it, more readily if heat is applied.

The presence of lead in any substance containing it may with certainty and ease be determined by heating the sample on a piece of well-burned willow charcoal, in one portion of which—nearest the flame—a small cavity or depression has been made, in which the assay may be placed, a little carbonate of soda added, and the flame of an oil lamp or large candle turned upon it by means of the mouth blowpipe. The direction of the flame at first should be downwards until the assay begins to melt, after which it should be blown softly and nearly horizontally across the charcoal. If lead is present in the assay a coating will form on the charcoal which is lemon yellow when hot and sulphur yellow when cold. Other volatile substances which may be present may also form coatings, but they will be characteristic, and at distances more remote from the assay, nor will they be the same color. Zinc, like lead, gives a yellow coating, which to the inexperienced might lead to mistakes, but if the charcoal is allowed to cool, the zinc coating will become white, by which reaction it may be distinguished.

The following are the reagents used in the determination of lead in the wet way, and the reactions which occur:

Hydrosulphuric acid or sulphide of ammonium added to solutions of lead salts, gives black precipitates of sulphide of lead, which are not soluble in cold dilute acids, alkalies, alkaline sulphides, or cyanide of potassium, but the precipitate may be decomposed by boiling nitric acid. The acid must be dilute or a part of the lead will be changed to the sulphate and remain insoluble.

Soda, potassa, and ammonia, throw down basic salts of lead in the form of white precipitates, which are insoluble in ammonia. The exception is solution of acetate of lead, from which pure ammonia (free from carbonate) does not immediately produce a precipitate, a soluble triacetate of lead being formed.

Carbonate of soda produces a white precipitate of basic carbonate of lead, when added in solution to the solution of any lead salt. This precipitate is not soluble in excess of the precipitant, nor in cyanide of potassium.

Hydrochloric acid or the soluble chlorides produce in solutions of the lead salts, if concentrated, a heavy precipitate of chloride of lead, which is soluble in a large quantity of warm water.

Sulphuric acid and sulphates throw down from lead solutions a heavy precipitate of sulphate of lead, which is nearly insoluble in water and dilute acids, but dissolves readily in solution of citrate of ammonia.

Chromate of potassa when added to solution containing lead throws down a beautiful yellow precipitate of chromate of lead, which dissolves in potassa, but which is nearly insoluble in nitric acid.

It should be understood that the above reagents are in solution, and are to be added in every case to solutions of substances containing lead.

Lead occurs in nature in a variety of forms, but most of the metal furnished to commerce is from galena or sulphuret of lead. Native lead is reported as occurring in globules at Alston Moor and at the mines near Cartagena, Spain, but never in sufficient quantity to work, or even to furnish specimens for the cabinet of the mineralogist.

Galena, the most abundant ore of lead, has a metallic luster. Its color and streak are pure lead gray. When broken it is still cubic in form, even when reduced to the finest powder. It always contains silver, and sometimes selenium, zinc, cadmium, manganese, gold, antimony, copper, and iron. Even platinum is said to be found in galena in France.

It is a mistake to suppose that any external appearance indicates the quantity of silver in a sample of galena.

There is a variety of galena which is called supersulphuretted lead. The excess of sulphur results from the decomposition of a portion of the galena, setting the sulphur free.

There are several minerals which resemble galena, and may easily be mistaken for it. The most common is micaceous iron, a variety of hematite. The resemblance of this mineral to galena is sometimes so striking as to deceive the inexperienced. It may, however, be distinguished by the following tests: When heated on charcoal it gives off no odor of sulphur, nor can it be fused before the blowpipe. No metallic beads are formed when carbonate of soda is added. After strong heating it becomes red, and on cooling is found to be attractable by the magnet.

Galena, anglesite, and cerusite have been noticed under their special headings.

ASSAY.

The assay of lead in the dry way is never absolutely correct, for several reasons: First, from the volatile nature of all lead compounds, making the result too small; second, from the tendency of other metals to alloy with the lead, as gold, silver, copper, antimony, etc., giving results too great; third, when sulphur is present some of the lead sulphide is liable to form a slag or "matte" without being decomposed, and thus to escape determination. Notwithstanding these sources of error, such assays approximate to the working of the ores in a large way, and when carefully made and verified by proofs, are generally accepted as correct.

The wet assay, although attended with some difficulties, is by far the most accurate and reliable.

Before lead ores are prepared for assay in the dry way, regard must be had to their chemical character. It is best to divide them into classes, each of which must be treated by a different process.

Class 1. Ores containing either sulphur or selenium, or both.

Example: Galena, clausthalite, lead matte or regulus, furnace products, etc.

Class 2. Ores containing oxide of lead combined with various mineral acids, sulphuric acid, chromic acid, phosphoric acid, arsenious acid, carbonic acid, etc.

Example: Anglesite, cerusite, pyromorphite, etc.

Class 3. Metallic lead alloyed with other metals.

It is easy to distinguish to which class a specimen of lead mineral belongs. It has already been shown how to test a mineral for lead. After doing so observe if it has a metallic luster and a certain degree of malleability, showing a bright metallic streak when freshly cut. It will not be difficult to determine if it is an alloy by these tests. If so, it evidently belongs to Class 3. If not, fuse a small piece with carbonate of soda on charcoal; when cold remove the slaggy mass and place it on a clean silver coin and add a few drops of water. If the silver is blackened so that the stain cannot be washed off with water, the mineral contains sulphur or selenium in some form. Before testing for sulphur with carbonate of soda and silver, the purity of the soda must be proved by wetting a small portion of it after fusion, and laying it on the bright silver. If pure, no blackening will appear. If the reverse should be the case, the reagent is worthless and should not be used; such soda can be purified, but the process cannot be explained here. As sulphate of lead belonging to Class 2 gives this reaction. A second piece of the ore must be placed in a clean glass tube, four or five inches long, open at both ends, and heated while holding the tube in an inclined position. If sulphur is present as a sulphide, or if selenium is present, the smell can easily be recognized if the upper end of the tube is held near the nose. If sulphur, the smell of burning sulphur will be observed. If selenium, that of rotten horseradish will be distinguished. If no sulphur is detected (Class 1) the substance belongs to Class 2.

Having decided to which class the substance belongs, it may be pulverized, passed through a sixty mesh sieve and thoroughly mixed.

If in a metallic state (Class 3) a portion may be cut off with a cold-chisel, rolled out thin and cut into shreds with a pair of scissors, or may be drilled and the borings taken for assay.

ASSAYING AVERAGE SAMPLES.

It is often required to sample a number of lead bars, and to make an assay representing the average of them all. The best method of proceeding is to drill a hole into each bar deep enough to obtain borings sufficient for duplicate assays. To insure a correct result it is best to take a portion from several parts of each bar; the samples should be numbered or marked to correspond with a similar mark or number on the bar. The bars are then weighed. If of uniform weight, equal portions by weight of the borings are thoroughly mixed and a portion of the mixture assayed, according to the directions to follow. If of unequal weights, the same weight in grams of each, corresponding to the weight of the bar in pounds, is mixed for assay. If extreme accuracy is desired, the result may be verified by making single assays of each sample, and taking the mean of the result.

ASSAYING FIRST-CLASS ORES.

There are a number of methods of assaying ores of the first class, each one having its own advocates:

1. *Fusion with carbonate of potash.*—In case the ore contains but little sulphurets other than those of lead, but more or less of earthy matter.
2. *Fusion with black flux.*—(Black flux is made by mixing two parts of argol and one part nitre in an iron vessel, setting the mixture on fire and allowing it to burn until all action ceases.)
3. *Fusion with or without fluxes in wrought iron crucibles.*
4. *Fusion with carbonate of soda and nitre.*
5. Fusion in clay crucibles with fluxes and metallic iron.

For all practical purposes the last mentioned is the best, and the modification proposed by Mitchell is simple and accurate.

For the assay, ordinary sand crucibles, triangular at the top, are used (called Hessian crucibles). The most convenient size is four and one half inches high. It is recommended to smear them inside with plumbago, but I have never found this precaution necessary. Twenty grams of the ore are weighed out and placed in the crucible; 5 grams of argol, 20 of carbonate of soda, 5 of carbonate of potash, and 10 of borax, are added, and the whole thoroughly mixed with a spoon or spatula. Three large nails are then placed, head downward, one in each corner. They must be pushed down to the bottom of the crucible, and the crucible tapped on the mixing table when the mixed contents form a level surface around the nails. The surface of the assay must then be covered with common salt (twenty grams will be about the amount required), and the crucible again tapped on the table, to settle all down evenly and compactly; ten grams of borax in lumps is put loosely on top, and the crucible is ready for the fire; a second crucible must be prepared exactly like the first for the duplicate assay. *No single assay should be trusted.*

PRECAUTIONS IN FUSING.

I have given the quantities of the fluxes by weight, but after practice the assayer will be able to mix the assays by using a spoon about the size of an ordinary tablespoon and judging of the quantities by his eye. A little more or less of the fluxes does not materially matter. He will soon be able to judge of the quantity required and from the appearance of his crucible in the fire know what to add to make it fuse freely. Any addition that may be required may be made by wrapping the dry flux in a piece of paper and dropping it into the hot crucible with the cupel tongs. There are certain precautions to be observed in fusing the assay. Too hot a fire is apt to volatilize a portion of the lead, causing loss, while too slow a fire does not effect the perfect fusion of the assay, and the globules which form cannot gravitate to the bottom, there to form a single prill or button. It is best to commence with a good fire which has burnt rather low, but in a hot furnace. The crucibles are placed on the hot coals and fresh fuel built up around them by putting in charcoal or coke, as the case may be, in lumps singly with the cupel tongs. The dampers and doors of the furnace are then arranged so as to produce the best draft. When the fresh fuel is igniting the fusion progresses slowly. The furnace soon becomes very hot, which is the exact condition required for the finishing of the fusion. The crucibles which are at first covered must toward the end be uncovered and the covers need not again be replaced. When the assays are in the most perfect state of fusion the crucibles may be removed one at a time with suitable crucible tongs. As soon as removed from the furnace a rotary motion should be given to them (soon learned by practice). This motion causes the fluid slag to sweep round the inside of the crucible, washing down to the center any stray globules. The nails are then removed by taking them out one by one with the cupel tongs, washing off any adhering lead by rinsing them in the liquid slag. When the nails are removed the crucible is tapped against the brick floor or against any hard non-inflammable substance, and set in some convenient and safe place to cool.

When cold the crucible must be broken on an anvil and the button of lead hammered into a cube and weighed. Both buttons should weigh alike or nearly so.

CALCULATING PERCENTAGE.

The calculation of percentage is simple: Suppose the twenty grams of ore contained 9.462 grams of lead; it is clear that 100 grams would contain five times as much. The number of parts in one hundred being the percentage, the result would be as follows: $9.462 \times 5 = 47.31$ per cent.

ANTIMONIAL GALENA.

Galena often contains antimony in the form of sulphuret, in which case the method described above would not give correct results. The presence of antimony may be proved by reducing a bead with carbonate of soda on charcoal. If the ore contains antimony white fumes will be given off, and a white coating on the charcoal will be seen more distant from the assay than the yellow coating of lead; or the finely pulverized ore may be shaken up with a solution of caustic potash, the solution filtered and acidulated with a strong acid; a yellow precipitate of sulphide of antimony will fall if the ore contains a sulphuret of antimony.

Antimonial galenas may be treated in such a way as to obtain the lead pure, or all the antimony combined with the lead at pleasure.

To obtain the lead only, the assay must be mixed with four times its weight of carbonate of soda covered with salt, lumps of borax placed on top, and treated in the furnace exactly as described in the first operation. No nails should be added.

To obtain the lead and antimony together, mix the assay with equal parts by weight of cyanide of potasium and carbonate of soda.

It is sometimes found to be economical and not objectionable to pour the assay into a small concave mold instead of breaking the crucible, which may be used for subsequent assays. This should never be done unless in cases where many assays are to be made of ore from the same mine.

WET ASSAYS OF FIRST CLASS ORES.

Assays of the ores of the first class may be made by the humid method as follows:

Pulverize the ore very finely, weigh ten grams carefully, boil in a flask with twenty C. C. of strong nitric acid on a sand bath until the ore is completely decomposed, and no more red fumes are given off. Pour out carefully into an evaporating dish and evaporate to complete dryness. Care must be taken in this operation that no violent spurting or decrepitation of the assay takes place by which any part may be lost. When the dry mass is cold it must be boiled with a strong solution of carbonate of soda. It should then be poured on a filter and well washed with distilled water. Dilute acetic acid is then cautiously added, by which it is dissolved, and passes through the filter into a clean beaker which must be placed to receive it. When the solution is complete, every portion of the solution must be washed from the filter with distilled water. Earthy matters remain in the filter.

If dilute sulphuric acid is now added to the contents of the beaker the whole of the lead is thrown down as sulphate, which may be placed on a weighed filter and thoroughly washed with distilled water and alcohol, dried at the temperature of two hundred and twelve degrees Fahrenheit, and weighed. The weight of the filter must be deducted from the weight obtained. The sulphate of lead contains 68.28 per cent of metallic lead. There are some sources of error to be avoided in this operation. If the precipitate is not thoroughly dried in the filter, correct results will not be obtained, neither will it do to heat the filter so hot as to char or partly burn it. It is better to take two filters made of the same paper, fold them together while cutting them, then separate them, place one in each pan of a balance, and carefully trim the heaviest with a pair of scissors until they weigh alike; fold them together again, put them in the funnel together, wash the precipitate on them, dry together in a steam bath, then separate them, place the one with the precipitate in one pan of the balance and the other in the other pan; the difference will be the weight of the precipitate. There is a method common with chemists of burning the filter and incinerating the ashes with the precipitate in a platinum crucible, at a red heat, but the conveniences are not found in ordinary assay offices. The details may be found in any work on quantitative analysis. With proper care, correct results may be obtained by drying the precipitate on the filter. In the process given above the following reactions occur:

First.—The nitric acid attacks the ore and oxidizes both the sulphur and the lead, forming sulphate of lead.

Second.—By evaporating to dryness, the excess of nitric acid is driven off, but leaving some nitrate of lead mixed with the sulphate.

Third.—The carbonate of soda decomposes the sulphate of lead, forming carbonate of lead and soluble sulphate of soda, which is washed out as directed with distilled water.

Fourth.—The dilute acetic acid poured on the filter decomposes the carbonate of lead and forms acetate of lead, which, being soluble, passes through the filter, leaving insoluble matter, if there be any, in the filter.

Fifth.—Sulphuric acid, being a stronger acid than acetic, combines with the lead, giving now the pure sulphate.

The calculation of the assay is made as follows:

It has been shown that sulphate of lead contains 68.28 per cent of metallic lead; it is clear that we must find that per cent of the sulphate of lead we obtain, which will be the amount of lead in ten grams of the ore. Suppose we obtain 7.46 grams of sulphate of lead in the ten grams of ore, then $7.46 \times .6828 = 5.09$ metallic lead. Ten grams yielding this (5.09), it is clear that 100 grams would yield ten times as much, which is the percentage. The result would then be as follows: Lead, 50.9 per cent.

ASSAYS OF CLASS TWO.

The assay of substances belonging to class two is very simple. Twenty grams of the ore is weighed out as in the case of assay of first class, ten grams of red argol and thirty grams of carbonate of soda are well mixed in the crucible, the whole covered with a layer of salt and tapped on the mixing table to settle all down. Put the crucible into an increasing fire and keep at low red heat for quarter of an hour. Then increase the heat until the contents of the crucible flow freely, tap gently and set it aside to cool, break the crucible, hammer the button into a cube and weigh. If arsenite of lead or sulphide of lead are present, use nails.

The humid assay of this class is made by heating ten grams of the substance to redness, and afterwards boiling it in a flask with dilute nitric acid (one part of acid to one-two of water by volume); when the action ceases pour the contents of the flask into an evaporating dish and cautiously evaporate to dryness, allow the dry mass to cool, add dilute nitric acid, gently warm for an hour, add water, boil, and filter. The solution now contains all the lead as nitrate; the precipitative washing and weighing may now be conducted as directed in humid assays of ores of the first class.

CLASS THREE—ALLOYS OF LEAD WITH OTHER METALS.

Alloys must be boiled with dilute pure nitric acid, the solution decanted from the precipitate, which must be washed with water and the washings added to the solution, which must then be filtered.

The solution may contain all the other metals likely to be present in alloys, except gold, platinum, antimony, and tin.

The solution (which should never be too dilute) must be mixed with dilute sulphuric acid slightly in excess. (This may be explained by stating that "excess" means the slightest quantity of reagent in excess of what is required to precipitate all of the lead.) The dilute acid should be added slowly, and the precipitate allowed to settle before further addition is made. When the sulphate of lead has all precipitated, double the volume of alcohol is added, and the whole set aside for a few hours to settle, after which it is decanted and washed into a small filter, washed with alcohol, and dried on a water bath, or in the sun. When the precipitate on the filter is perfectly dry, a clean piece of writing paper is spread on a table, and a small clean porcelain cup set in the center of it. The precipitate must then be carefully detached from the filter, and transferred to the cup. The dry filter is then held in a pair of small pliers over the cup, and burned by applying a match or candle flame; the ashes which fall on the paper must be brushed into the cup. The cup may then be placed on a piece of wire gauze, set on the ring of a retort-stand, and heated from below with a spirit lamp to a red heat. When cold, the cup and contents are weighed, and the tare of the porcelain cup deducted; the remaining weight will be that of the sulphate of lead obtained from the alloy.

The weight of the alloy taken for assay and the calculation are the same as in the last example.

When great accuracy is not required the use of alcohol may be dispensed with, but more excess of sulphuric acid must be used for precipitation, and the washing water must contain some dilute sulphuric acid.

RECEIPTS, MANUFACTURE, AND EXPORTS OF LEAD.

Although some of the mining districts of California abound in plumbiferous ores, lead mining as a distinct business has never been pursued in this State, nor have we here treated any ores of this class exclusively for the lead they contained. At the works of the Selby Smelting and Lead Company, located in San Francisco, large quantities of argentiferous galena have been reduced, but the ore was mostly obtained from the Castle Dome district, Arizona. So, also, at these works, have many thousand tons of lead-silver bullion been parted and refined, this bullion coming nearly all from the mines of Eureka, in the State of Nevada, or from the Cerro Gordo district, in California. This company turn out an average of about 6,000 tons of lead per year, one half of which is exported, and the remainder manufactured by them into sheet, pipe, shot, and other articles composed of lead, of which they supply about all that is required on this coast. For a number of years we exported to China about 5,000 tons of lead annually. Lately we have sent very little to that country, the market there being supplied now mostly from England.

THE COST OF MINING AND SMELTING.

For the benefit and guidance of those interested in mines producing smelting ore, we give some complete and authentic figures on the subject, furnished to the *Inyo Independent* by Mr. W. Belshaw, of the

Union Consolidated Mining Company, Cerro Gordo, Inyo County, California. These figures are taken from practical work and results, and are therefore of more than ordinary interest. The statement covers a period extending from February 1 to October 1, 1876:

Total cost of mining and reduction, including interest on capital, $198,525 84, viz.:

Mining expenses	$154,966 61
Furnace expenses	137,822 36
Interest expenses	5,736 87

Cost of mining 9,950 tons ore, $54,966 61, viz.:

Labor	$37,695 55
Water	1,871 79
Hauling ore	5,143 63
Powder and fuse	585 10
Candles	840 00
Wood	1,508 50
Blacksmithing	937 46
Timbers and lagging	1,505 22
Freights and sundries	2,379 36
Superintendence	2,500 00

Carbonates and oxides (soft ores)	8,220 tons
Estimated cost per ton for mining	$4 43
Sulphuret or galena ores	612 tons
Estimated cost per ton for mining	$10 00
Silver-bearing quartz ores bought and mined	1,118 tons
Estimated cost per ton	$11 00
Average assay of 8,220 tons	20 per cent lead
Average assay of 612 tons	70 per cent lead

WAGES AT MINE.

Foremen and engineers, per day	$5 00
Ordinary labor, per day	4 00

Mining Superintendent, J. L. Porter.

Cost of reduction of 9,950 tons of ore, $137,822 36, viz.:

Coal, 1,960⅗ tons, at $38 per ton	$74,405 28
Labor	31,339 87
Wood	4,067 12
Water	8,367 21
Blacksmithing	458 29
Freights	2,456 64
Superintendence	4,999 66
Paid men accidentally injured	474 35
House expenses	3,235 56
San Francisco office expenses	714 75
Stable expenses	761 38
Cerro Gordo office, legal, taxes, surveying, and sundry expenses	1,650 00
Tools, oils, and repairs	4,892 25

Cost per ton of ores, reduction	$13 85
Cost per ton of ores, mining	5 53
Cost per ton of ores, interest	58
Total per ton for mining and reduction	$19 96

WAGES AT FURNACE.

Engineers and chargers, per day	$5 00
Ordinary labor, per day	4 00

Superintendent of furnace, Hugh Morrison; Assistant Superintendent, Wm. E. Goodrum.

Total running time of furnaces, 331 days; tons of lead produced, 1,325—or 64 per cent of lead assay; 90 per cent of silver values saved.

Yours respectfully,

M. W. BELSHAW, Sup't Union Con. M. Co.

DIMINISHED RECEIPTS.

The rate at which San Francisco receipts of both lead and base bullion have fallen off during the last six years is shown by the following table, the amounts being expressed in pounds:

Years.	Base Bullion.	Lead.
1878	21,568,800	3,669,700
1879	11,926,500	1,815,000
1880	4,422,900	8,431,800
1881	4,344,600	12,114,000
1882	1,949,200	4,510,800
1883	1,634,800	1,470,400

The extension of mining operations in the southeastern part of the State will be likely to increase receipts of the above products at San Francisco hereafter. The low prices ruling for lead ($72 per ton of 2,000 pounds in the New York market), has had a tendency to restrict production everywhere, these being figures that leave little chance for profit to either the miner or smelter. As the Leadville ores are becoming much impoverished, the enormous output made for several years past at that great center of production must suffer serious curtailment in the future, causing a corresponding hardening in prices.

The Duty on foreign lead imported into this country in pigs, bars, etc., is two cents per pound; on lead manufactured into sheets, pipes, or shot, three cents per pound; a tariff that affords the domestic producer ample protection so far as the home market is concerned.

The Production of Lead in the United States, commencing a little over fifty years ago at the rate of about 1,000 tons per year, has gone on increasing since, till it reaches now about 140,000 tons—the product of 1882 amounting to 133,000 tons. The increase during the last twelve years, since the opening up of the Utah, Nevada, and Colorado mines, has been very rapid. Most of the lead formerly produced in this country was from the mines in Wisconsin, Missouri, and other Western States, which, for the ten years preceding 1849, had made an output varying from 15,000 to 25,000 tons per year. After 1850 the product in these Western States fell off rapidly, many of the miners having left for California. Prior to 1875 a good deal of lead was imported into the United States, as much some years as 40,000 tons—generally, however, much less; some years none at all. Since 1875 imports have dwindled to a small amount—less than 4,000 tons per year. The bulk of these importations has throughout, under the operation of the drawback provision in the law, been reëxported in the shape of solder on tin cans containing petroleum, fruits, etc.

WHITE LEAD.

The Pioneer Works of Whittier, Fuller & Co.—We have but a single establishment for the manufacture of white lead on this coast, that of Whittier, Fuller & Co., situated on Fremont Street, between Howard and Folsom, in this city. These works are very extensive, being five stories high, and reaching from Fremont to Beale Street, 275 feet. The acid works and corroding sheds, adjoining the main building, have a frontage of 185 feet on Fremont, whence they extend back 275 feet to Beale Street. The machinery, apparatus, and processes employed are as perfect, probably, as any in use; there being claimed for some of the processes here introduced a special excellence. About 250 tons of pig lead are consumed here monthly. From this quantity of metal there is made an equal amount of white lead, the product of these works going far towards supplying the entire demand of the coast. The lead worked up here is obtained mostly from Utah and Colorado, but little being now received from Nevada. There are employed in the different departments of this establishment about 120 men, some of whom are highly skilled in special lines of the business, such as making paints, grinding colors, etc. Besides white lead, this firm manufacture what is known as Pacific rubber paint. As everything connected with this industry—the lead, acid, linseed oil, packages, etc.—is the product of this coast, these works give employment, directly and indirectly, to a large amount of labor, besides retaining in the country considerable sums formerly sent abroad to purchase the commodities made here.

By reason of so much white lead of superior quality being turned out at these works, the imports of this article at San Francisco have of late years been small. The quantity of the white lead made in the United States during the year 1880 amounted to 123,477,800 pounds, valued at $8,770,699.

81. LENZINITE. Hydrous Silicate of Alumina.

"Mountain Butter" is found in cavities in rocks at the mouth of Pine Creek Cañon, Alabama Range, Owens Valley, Inyo County. (Aaron.) This mineral is probably Lenzinite.

82. LEPIDOLITE. Etym. *Scale Stone* (Greek). Lithium Mica.

This beautiful mineral has recently been found in California, at several localities, with erythrite and rubellite. It is a pink colored, scaly mineral, containing from 2 to 6 per cent of lithium. The California mineral has not yet been analyzed. It might, at some future time, be found profitable to extract lithium from it. The salts of lithium are principally used in fireworks and in medicine. The California localities are represented in the State Museum by Nos. 1229, San Diego County; 2773, twenty miles southwest of Colton, San Bernardino County; and 4262, with azurite, from the Half Dollar mine, Inyo County.

83. LEUCOPYRITE. Etym. *White* (Greek), and *Pyrite;* Arsenical Iron.

Said to occur in Los Angeles County, exact locality not given.

LIGNITE—see Mineral Coal.

LIME—see Calcite.

LIME GARNET—see Grossularite.

LIMESTONE—see Calcite.

84. LIMONITE. Etym. *Meadow* (Greek). See, also, Iron Ores.

This is a hydrous sesquioxide of iron, found sometimes compact and fibrous, at others earthy and dull. When pure, it has the following composition:

Sesquioxide of iron	85.6
Water	14.4
	100.0

Equivalent in metallic iron, 59.3 per cent. Limonite is sedimentary, and results from the weathering of rocks containing iron. It sometimes forms large beds in low marshy lands, and is known as bog iron ore. It also occurs in strata generally underlying gravel and clay, intimately mixed with fine sandy silt. When of a golden yellow color, it is called yellow ochre, in which form it is extensively used as a pigment. In both forms it is quite abundant in the State; in the former it is a valuable ore of iron, but more likely to contain sulphur and phosphorus than other iron ores. A large portion of the ore now being worked at Clipper Gap, Placer County, is limonite. Yellow ochre of most excellent quality is found at several localities in California. It was first discovered at Knight's Ferry, Stanislaus County, many years ago, and attempts were made to utilize it, but the market at that time was limited, and large stocks were held by the importers, who discouraged home production. The time has now arrived when it can be worked to advantage, and its production will retain considerable money in the State, and give remunerative employment to a few persons. Before yellow ochre can be used it must be submitted to a washing process to remove the sand and other impurities. This may be done on the ground, by the very simple process of breaking it up in a pug mill, such as used in brick making, or in a tub planned like an arastra, or silver mill separator. Whilst being agitated, water is allowed to flow in and out of the vat, and the outflow being near the top, the heavy sand and gravel, etc., is retained, the water carrying off only the fine ochre. Below the agitator a succession of vats, of convenient form and size, are arranged, through which the yellow muddy water flows. They should continue so far that the water will pass from the last one quite clear. The ochre will settle in the tanks, being finest in the one most distant from the agitator. When sufficient has accumulated the operation may be discontinued, and the yellow mud, which is the refined ochre, shoveled out and allowed to dry. It should be so fine that no grit can be felt when it is crushed between the fingers, and it should mix with oil to a smooth paint without grinding, which, when laid on, should show no sign of gritty particles. When yellow ochre is calcined it becomes red. The following localities of limonite are represented in the State Museum:

(2455.) Between Jenny Lind and Campo Seco, Calaveras County.
(3002.) Gold Lake, Sierra County.
(3760.) San Andreas, Calaveras County.
(3762.) San Luis Obispo County.
(3763.) Near Campo Seco, Calaveras County.
(3766.) Near Big Trees, Calaveras County.
(3774.) Twenty-five miles east of Visalia, Tulare County.
(4148.) Near Latrobe, El Dorado County.
(4907.) Five miles from Alameda, Alameda County.

YELLOW OCHRE.

(4010.) Near Campo Seco, Calaveras County. Bright golden yellow color.
(4011.) The same, calcined. It is a very deep rich red color.
(5301.) Yellow ochre of good color and quality, found in large quantities on Section 32, Township 12 north, Range 11 east, four miles east of Georgetown, El Dorado County.

85. LITHARGE. Etym. *Silver Stone* (Greek).

This substance has been found in San Bernardino County. It is probably a furnace product, made in prehistoric times. It has been found also in Arizona, in localities remote from the Missions, and under circumstances leading to the opinion that the furnaces, now obliterated, were erected and worked by the people who dug the irrigating canals, and built the Casa Grande, in the Valley of the Gila River, and lived in the ancient cliff dwellings.

LITHOGRAPHIC STONE—see Calcite.

86. LITHOMARGE. Etym. *Marl Stone* (Greek and Latin).

A fine grained hydrous silicate of alumina, probably sedimentary. It contains generally magnesia and lime. No. 423, in the State Museum, is from the Alpha mine, Table Mountain, Tuolumne County, called "pipe clay;" No. 2515 is from near the Big Trees, Calaveras County; and No. 4498 from Lassen County.

LOADSTONE. Natural Magnet—see Magnetite.

MACLE—see Andalusite.

MAGNESIAN LIMESTONE—see Dolomite.

87. MAGNESITE. Etym. *Magnesia* (Greek). Carbonate of Magnesia. ($Mg\ O, CO_2$.)

Magnesia	47.6
Carbonic acid	52.4
	100.0

H 3.5—4.5, sp. gr. 3. Color generally white, sometimes yellowish, with dark colored streaks. Fracture conchoidal, with sharp edges; dissolves in hot muriatic acid with effervescence. This valuable mineral, which is rather abundant, is used in the arts, principally in the manufacture of cements, and also as a convenient source of magnesia salts. There is a sample of hard artificial stone in the State Museum, No. 2791, thus described:

Artificial stone, made from magnesite, from Coyote Creek, near Madrone Station, S. P. R. R. The rock was calcined, pulverized, and mixed with solution of chloride of magnesium, made by dissolving a portion of the powdered rock in common muriatic acid to about the consistence of cream. This was used as a cement to unite broken rock into a kind of concrete. In this specimen broken marble was used, as being most convenient at the time.

The following is the *Hohlweg Process* for obtaining magnesium sulphate from crude mineral (patented June 6, 1882):

I take the crude mineral containing carbonate or silicate of magnesia, and reduce it to a fine powder, and mix with it, either when pulverizing or afterwards, about six times its weight of bisulphate of soda. The whole is placed in a tank, or vat, with a suitable quantity of water, in which condition it is kept for about twenty-four hours, and occasionally agitated by stirring the mass. By this means one equivalent of the sulphuric acid contained in the bisulphate of soda combines with the magnesia, from which action a mixture of sulphate of soda and sulphate of magnesia is obtained. To the resulting solution of sulphate of soda and sulphate of magnesia I add carbonate of soda in quantity required, to precipitate the magnesia from the solution as carbonate in the usual manner. Should iron be present in the mixture, this may be removed in the usual way, and the pure sulphate of magnesia may be obtained from the solution by successive evaporation and crystallization, the sulphate of soda having first been removed by evaporation and crystallization, and afterwards the sulphate of magnesia.

While carbonate of magnesia is found at numerous localities in the State, the following are the most important: On Coyote Creek, about two miles from Madrone Station, S. P. R. R., Santa Clara County, near the road is a large deposit; Nos. 1195 and 5159 are from Gold Run, and Damascus, Placer County, where it occurs in large quantities; No. 3025 contains silica, and under the microscope shows a cryptocrystalline structure; it is from a vein two feet wide on Arroyo Seco, Monterey County.

The following localities are given by W. P. Blake:

Tulare County, near Visalia, between Four Creeks and Moore's Creek, in solid beds of pure white massive carbonate of magnesia, hard, fine grained, and like unglazed porcelain in texture. The beds are from one to six feet thick, and interstratified with talcose slates and serpentine. Similar beds are described to me as existing in the Diablo Range, Alameda County, about thirty miles south of Mount Diablo.

Mariposa County and Tuolumne County.—A heavy bed of magnesian rock, chiefly magnesite, charged with crystals of iron pyrites, accompanies the chief gold-bearing quartz vein of those counties. This rock is charged also with nickel and chrome talc in green films, like the magnesite of Canada.

No. 4675 is an artificial carbonate of magnesia, obtained as a by-product in the tanks, in working the mother liquors from the manufacture of salt, by the Union Pacific Salt Company, Alameda County, and largely used in the manufacture of explosives.

Magnetic Pyrites—see Pyrrhotite.

Magnetic Sands—see Magnetite.

88. MAGNETITE. Etym. *Magnesia Stone* (Greek). Magnetic Iron Ore. (FeO, Fe_2O_3.)

Protoxide of iron	31.03
Sesquioxide of iron	68.97
	100.00

Equivalent to:

Iron	72.4
Oxygen	27.6
	100.0

H=5.5—6.5, sp. gr.=4.9—5.2. Color and streak, black; opaque, brittle; attracts the magnet, and deflects the magnetic needle strongly; frequently it possesses polarity, in which case it repels the magnetic needle and attracts soft iron in small fragments; it is then called natural magnet, or loadstone. Magnetite takes its name from Magnesia, a town in Asia Minor, where it was first discovered by the ancients; and it is stated that a shepherd, while herding his sheep, observed that the iron ferrule of his staff and the nails in his shoes adhered in some places to the ground, which led to its discovery. The words magnetic and magnetism have the same derivation. It is said that the first mariner's compass of the Chinese was a fragment of loadstone, floated on a cork in a vessel of water. Advantage is taken of the magnetism of ores of iron by using a dipping needle in searching for them. As the prospector passes over the ground, the downward deflection of the needle indicates bodies of iron ore beneath the surface. Magnetite is a valuable ore of iron, and exists with other ores in numerous localities in California. The following are known localities, arranged by counties:

Amador County. Two miles northeast of Jackson, magnetic sand, with pyrite. No. 65, Sutter Creek.

Butte County. With native copper, in the Lincoln Tunnel. No. 2788, Ball Creek, near Oroville.

El Dorado County. Volcanoville (Blake). Crystals in slate, near Boston copper mine, and with quartz and pyrite, Excelsior copper mine (Blake). No. 965, two miles northwest of Shingle Springs. No. 1667, near Big Red Ravine, two miles from Coloma. No. 4254, Clarksville.

Inyo County. Magnetite is found in a number of localities in the Inyo Mountains. Fine specimens of loadstone have lately been sent to the State Mining Bureau, from the Slate Range, where it exists in quantity.

Los Angeles County. In the Canada de las Uvas there is a vein, three feet thick, in limestone (Blake). No. 4644, thirty miles north of Los Angeles.

Mariposa County. East of the Mariposa estate (Blake). No. 1996, near Coulterville. No. 3005, base of Mount Hoffman.

Mono County. In a vein, five miles south of Benton, with steatite and gold (Aaron). No. 3639, Indian district. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; total, 100.00; graphite and sulphide of copper, traces. No. 3768, near Benton. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; traces of sulphide of copper. This ore is said to be in very large quantities. Loadstone. Spur of White Mountains, half a mile south of Montgomery (Aaron).

Napa County. No. 3757, near St. Helena.

Nevada County. No. 4569; magnetic sands with gold and pyrite, concentration from hydraulic mines. No. 5767, Grass Valley.

Placer County. Utt's Ranch (Blake). Near New England Mills. No. 1333, six miles from Auburn, large deposit. No. 1938, Section 15, Township 13 north, Range 8 east.

Plumas County. (After pyrite) Armentine mine, with epidote and garnet (Blake). Mumford's Hill (Edman). No. 117, near Gold Lake, line of Plumas and Sierra Counties. No. 3361, with hematite, near Crescent Mills.

San Benito County. No. 819, Tres Pinos. No. 2274, Coast Range Mountains. No. 4344, fourteen miles from Hollister, in large quantities with limestone.

San Diego County. No. 2886, eight or nine miles north of Mesquit Station.

Santa Barbara County (Trask).

Santa Cruz County. Near the town is an extensive bed; the needle deflected 31 degrees on approaching it (Trask).

Shasta County. At Iron Mountain, five miles from the Sacramento River. Altitude above river, 1,300 feet. An abundance of wood at $2 50 per cord, and plenty of water at the mine. Analysis by Kellogg, Hewston & Co.: Protoxide of iron, 11.58; sesquioxide of iron, 80.15; alumina, 1.69; silica, 4.95; water, 1.63. No. 20, McCloud River. Nos. 1761 and 4383, Potter's iron mine, seven miles from Shasta. No. 4139, in octahedral crystals, exact locality not known.

Sierra County. In large beds (Blake). No. 3756, Mohawk Valley, Sierra Iron Company.

Sonoma County. No. 4238, mouth of Russian River; magnetic sands.

Trinity County. Near Weaverville (Trask).

Yuba County. No. 579.

89. MALACHITE. Etym. "*Mallow.*" Green Carbonate of Copper, Mountain Green. ($CuO, CO_2 + CuO, HO$.)

Protoxide of copper	71.9
Carbonic acid	19.9
Water	8.2
	100.00

Equivalent of copper, 57.39 per cent. H=3.5, sp. gr. 3.7—4. Color bright green; streak paler. It dissolves in acids with effervescence, the solution becoming bright blue if ammonia is added in excess. B. B. on ch. fusible, a globule of copper is easily obtained. In a closed tube it blackens and yields water. This mineral is valuable as an ore of copper, but still more so as an ornamental stone when found in masses of sufficient size. Magnificent vases, tables, and mantels of malachite were shown in the Russian department of the Paris Exposition of 1878. The same objects had been exhibited at previous World's Fairs. While malachite has been found in numerous localities in California, it has never been obtained in sufficient quantity to be used for ornamental purposes. Malachite when ground and properly washed has been somewhat used as a pigment under the name of "Mountain Green," but it is not so good for that purpose as some of the artificial greens.

CALIFORNIA LOCALITIES.

In remarkably fine specimens, associated with crystalline blue carbonate, at Hughes' mine, Calaveras County (Blake). At Alisal, Monterey County (Trask). Santa Rosa Creek, San Luis Obispo County; San Emidio Ranch, Kern County, with melaconite. Copperopolis, Calaveras County; Del Norte County; Plumas County, with azurite, gold, and quartz. Whitman's Pass, Tuolumne County. No. 672, with cuprite, azurite, and chrysocolla, in the Lost mine, thirty miles west of the Colorado River, San Diego County. No. 816, Peck mine, Copper Hill, Shasta County. No. 4746, with azurite, cuprite, and partzite, in the Kerrick mine, Blind Springs, Mono County; also at a number of localities in the Inyo and Coso Mountains.

MALTHA—see Petroleum.

MANGANESE OXIDE—see Pyrolusite.

90. MARIPOSITE. *Mariposa County.* (Provisional name.)

This is a mineral of an apple green color, found with quartz, on the Mariposa estate, Mariposa County; and elsewhere on the great mother lode of the State. It has not yet been fully determined. It is referred by Dana to fuchsite. It was first described by Prof. Silliman, December 2, 1867: see Proceedings of the California Academy of Sciences, vol. 3, fol. 380. It is represented in the State Museum by No. 1295, from the Josephine mine, Mariposa County.

MARBLE—see Calcite and Building Stones.

91. MARCASITE. Etym. ancient name for *Pyrite* (Arabic or Moorish origin). Sulphide of Iron, White Pyrites.

This mineral has the same composition as pyrites, but is of a white color. It is put to the same uses, such as making sulphur, sulphuric acid, etc. It is quite common as an associate of gold in California with pyrite (yellow colored), chalcopyrite, galena, sphalerite, mispickel, etc.

92. MELACONITE. Etym. *Black* (Greek). Black Oxide of Copper.

This is a rare mineral in California. It is said to occur with malachite at the San Emidio ranch, Kern County. No. 812 is from the Afterthought mine, Shasta County. Melaconite occurs in the Satellite copper mine, formerly the Lancha Plana, near Campo Seco, Calaveras County, in masses of considerable size, with bornite, and containing granules of metallic copper the size of bird-shot. In the R. F. with chloride of ammonia it imparts an intense blue color to the flame. It is partly soluble in hydrochloric acid and is decomposed in nitro-hydrochloric acid with the separation of sulphur. This mineral occurs in nodules black and earthy inside but covered with a white incrustation.

93. MENACCANITE. Etym. *Meñaccan*, in Cornwall, England. Ilmenite, Titaniferous Iron.

A single but fine crystal was found in the gold washings near Georgetown, El Dorado County. It was about an inch in diameter with brilliant planes (Blake). Fine specimens are brought from Bill Taylor's ranch near Buchanan, Fresno County, twenty miles southeast of Mariposa. No. 2731 is from this locality.

MERCURY—see Quicksilver.

94. METACINNABARITE. Etym. *Beyond* (Greek) and *Cinnabar*.

This rare mineral is a black sulphide of mercury, described by G. E. Moore in 1870. It resembles cinnabar in composition, being like that species (Hg S), but differs from it in color, streak, specific gravity, and luster. It corresponds to the black sulphide of mercury produced artificially by mixing the elements; while cinnabar conforms to the artificial sulphide obtained by sublimation. It occurs with cinnabar and native mercury in several quicksilver mines in California, and has lately been found in Oregon. It has never been obtained in large quantities like cinnabar, and is still considered a rare mineral. When first found it was generally thought to be amorphous, but it has since been found beautifully crystallized in the Redington mine, Napa County, the locality where it was first discovered. Fine specimens have been obtained in the Great Western mine, Lake County; in the California mine, Yolo County, No. 448, amorphous, and No. 540 in crystals; and in the Bonanza mine, Douglas County, Oregon, associated with cinnabar, No. 4455.

95. METEORIC IRON.

Meteoric iron is of cosmical origin, having fallen to the earth from space. There are numerous theories as to the source from which these bodies come, but the question is far from being solved. Every new meteorite is studied, with a view to gain additional information upon this very interesting subject. The fall of aerolites has been observed from the earliest historical times, and regarded with awe and wonder. It is a singular fact that meteorites contain the same elements that are found on the earth; twenty-two of the known elements having been found in aerolites, the principal ones being iron, nickel, hydrogen, cobalt, silica, manganese, and aluminium. Some meteorites are found to have absorbed a large quantity of hydrogen gas in their passage through space; but although a few combinations are found which have not been observed in terrestrial matter, no new element has as yet been discovered in any of them. Meteoric stones are classed in two groups: those containing metallic iron (siderites), and those which do not—*stony* meteorites. These groups are again subdivided.

The iron meteorites have the singular property of developing or revealing crystalline structure when a smooth surface is acted on by dilute nitric acid. These crystals are called Widmannstattian figures, from the name of the discoverer. Some aerolites show this crystallization without etching, as is the case with both of those in the State Museum, to be described. In 1866 Dr. Trask found a small fragment of iron in Honcut Creek, Butte County. It had the appearance of cast iron, and was pronounced by Professor Brush not to be meteoric. Still it was considered remarkable at the time, that a fragment of cast iron should have been found under the circumstances, and it is a little singular that a similar fragment has been recently sent to the State Mining Bureau which was found on the bedrock, near Columbia, Tuolumne County. At a meeting of the California Academy of Sciences, February 19, 1866, Professor Whitney stated that Dr. J. G. Coffin had found fragments of iron in the bed of the Mohave River. At that time no meteorite had been found in California that was known to be such.

There was a rumor, a number of years ago, that there was a large mass of meteoric iron on the line of travel up the coast, a few miles north of Crescent City, Del Norte County, but it could never be traced to any reliable source. The El Dorado meteorite was found at Shingle Springs, by a blacksmith whose name is not given. It was noticed by J. H. Crossman in 1871, and placed in the cabinet of W. V. H. Cronise, where it was seen and described by Professor B. Silliman, in the *American Journal of Science and Arts* for July 18, 1873, with a figure from a photograph by Watkins of San Francisco. A short notice of it by Professor C. U. Shepard of Amherst College, appeared in the same journal of June, 1872. The weight of this meteorite was about eighty-five pounds avoirdupois. Its largest dimensions were twenty-four and twenty-nine centimeters; density, 7.875. No Widmannstattian figures were developed by etching.

The following analysis of it by J. A. Cairns, of the School of Mines, Columbia College, New York, is published:

Iron	81.480
Nickel	17.173
Cobalt	.604
	99.257

With the following elements in small proportions: aluminium, calcium, carbon, chromium, magnesium, phosphorus, potassium, sulphur.

Professor Shepard arrived at quite different results, viz.:

Iron	88.02
Nickel	8.88
Insoluble	3.50
	100.40

This meteorite still remains in San Francisco.

The *San Bernardino Meteorite*, No. 2339, State Museum, was found in 1880 in the Ivanpah mining district, San Bernardino County, by Stephen Goddard. The weight, before cutting, was 1,870 troy ounces. Dimensions: length, 13.5 inches; width, 9.7 inches; thickness, 8 inches. Specific gravity of the mass, 7.693. It is an irregular body or mass of malleable iron. The surface is covered with concave cup-like depressions, some of which have considerable depth. The fine Widmannstattian figures on the cut face were developed by the action of nitric acid, and the smooth rim or border was protected from the action of the acid by wax, and should not be mistaken for a crust or outer shell. On one end of the aerolite may be seen distinct crystals corresponding to those developed by acid. Photographs, on a scale of one third the actual size, were taken of this specimen, both before and after cutting. Lithographs from these photographs are published with this report. The following analysis was made in the University of California by Mr. Gustav Gehring:

University of California, Berkeley, May 17, 1884.

Analysis of the San Bernardino Meteorite by Gustav Gehring, Assistant in Chemistry in the University of California:

Iron	94.856
Nickel	4.469
Cobalt	.261
Silica	.041
Sulphur	.004
Phosphorus	.002
Carbon in combination	.115
Graphite	.067
	99.815

Hardness, 3.75; specific gravity, 8.076.

The *Chilcat Meteorite*, No. 2925, State Museum, was purchased by the State Mining Bureau from Chief Donawack. It is from Portage Bay, Chilcoot Inlet, Alaska. Its weight is 1,410 troy ounces, or about 96¾ pounds avoirdupois. The State is indebted to the Northwest Trading Company, and to J. M. Vanderbilt in particular for negotiating its purchase, and to John Muir for calling attention to it. No analysis of it has yet been made, but a small fragment treated with acid developed Widmannstattian figures.

PLINY'S NATURAL HISTORY.

Book 2, Chapter 59, "Of stones that have fallen from the clouds." The opinion of Anaxagoras respecting them:

The Greeks boast that Anaxagoras, the Clazomenian, in the second year of the 78th Olympiad, from his knowledge of what relates to the heavens, had predicted, that at a certain time, a stone would fall from the sun. And the thing accordingly happened in the daytime in a part of Thrace, at the river Ægos. The stone is now to be seen, a wagon-load in size, and of a burnt appearance; there was also a comet shining in the night at that time. But to believe that this had been predicted would be to admit that the divining powers of Anaxagoras were still more wonderful, and that our knowledge of the nature of things, and, indeed, everything else, would be thrown into confusion, were we to suppose either that the sun is itself composed of stone, or that there was even a stone in it; yet there can be no doubt that stones have frequently fallen from the atmosphere. There is a stone, a small one, indeed, at this time, in the Gymnasium of Albados, which on this account is held in veneration, and which the same Anaxagoras predicted would fall in the middle of the earth. There is another at Cassandria, formerly called Potidæa, which from this circumstance was built in that place. I have, myself, seen one in the country of the Vocontii, which had been brought from the fields only a short time before.

96. MICA. Etym. "*A Crumb* or *Grain*" (Latin). Isinglass, Muscovy Glass, etc.

This name is not confined to a single mineral, but is applied to a group, the members of which are silicates of a variety of bases; all having a cleavage parallel with the base of the crystal. This cleavage is so perfect that the mineral can be divided into sheets thinner than paper. It is to this property, and their transparency, that they owe their value in the arts. The minerals most characteristic of the mica group are Biotite, Phlogopite, and Muscovite.

There seems to have been a confusion in the use of the name mica among the earlier mineralogists; they applied the term to any mineral which could be separated into scales or lamina, regardless of its composition. Mohs, in his treatise on mineralogy, includes a number of minerals which are not now placed in the mica group, as follows: "Euchlore mica," hydrous arseniate of copper; "Cobalt mica," arseniate of cobalt, erythrite; "Iron mica," phosphate of iron, vivianite, and micaceous iron ore; "Graphite mica," foliated graphite; "Talc mica," chlorite; "Uran mica," phosphate of uranium, torbernite.

In the second annual report of the State Mineralogist, folio 225, considerable space was given to the description of mica, and of the specimens in the State Museum at that time. No new localities have since been found which have any importance. The following is a quotation from the paper mentioned:

In crossing certain streams or rivers flowing in shallow sandy beds, quartz sand may be seen to roll forward beneath the water, remaining near the bottom; but particles of mica, frequently of a golden color, rise with the force of the stream to the surface, and glitter and gleam in the sunlight like particles of gold, for which they have often been mistaken. This peculiarity of mica was frequently noticed in the Platte River by the early emigrants to California, and by those who had discovered the mistake it was called *"Fools' Gold."*

There is a specimen of yellow mica schist, No. 1626, in the Museum of the State Mining Bureau, from a large deposit, which caused the Gold Lake excitement, and it is so like the precious metal in appearance that it is not surprising the mistake should have been made. With the advancement of invention there has been created an increased demand for mica, which has raised the price to that extent that a deposit of the best quality would be very valuable to the finder.

Mica is made a substitute for glass in certain cases where that material cannot be used, as in front of stoves, bakers' ovens, furnaces, certain lanterns, lamp chimneys, windows in ships of war, as such windows cannot be broken by the concussion of the guns. In chemistry it is sometimes used as a support for substances to be fused, and as thin covers for microscopic objects where it is desirable to have the cover thinner than can be attained by glass; it is also used in the pans of the balance upon which to place powders and damp or corrosive substances to be weighed. In this case two pieces of equal size and weight are used, which counterpoise each other.

Mica is also applied to ornamental purposes. In paper hangings and decorative work it is ground or otherwise separated into a fine scaly powder and sifted over the work in a kind of frosting, which is made to adhere by a coating of glue size or paint. Mica of a yellow color is said to be used in the manufacture of artificial aventurine.

Mica, being a constituent of granite, gneiss, and other of the more common rocks, is one of the most abundant minerals in nature. But it is only when it occurs separate and alone, and under other peculiar conditions, that it possesses any special value. Mica, in sheets or plates of the size and quality that adapt it for the uses to which it is mostly applied, is a mineral that, where the conditions are favorable, can be mined with profit. Nevertheless, much misapprehension seems to exist among miners as to the requirements of the trade and the prices usually paid for this mineral; the idea having obtained among this class that mica is so scarce and in such demand, that there is always a market for it at extravagantly high figures. But this is a mistake; it is only sheets of superior quality and extra large size, such as are rarely found, that meet with ready sale at high prices. Owing to the erroneous notions entertained on this point, the several attempts that have been made at working the mica deposits of California and Nevada have resulted in disappointment and loss, the parties who engaged in these enterprises having failed to realize for their product such prices as they had counted upon, chiefly because it did not quite meet the wants of purchasers. The outlook for this industry is, however, by no means desperate, as there are many promising deposits of mica in California, and elsewhere on the coast, and there is a chance that the quality of the article will improve when the mines come to be opened to greater depths.

WHERE FOUND.

The following include the principal localities at which this mineral has been found in California: At Gold Lake, Plumas County; in El Dorado County; Ivanpah district, San Bernardino County; near Susanville, Lassen County; and at Tehachipi Pass, Kern County; it having been observed at many other places in the State. As little or no work has been done on any of these deposits, not much can be said in regard to their probable value, one way or the other. We have reports of mica being found in nearly all the Pacific States and Territories; also in those contiguous to the Rocky Mountains; its occurrence in some of these being abundant, and extending to many different localities.

Micaceous Iron—see Hematite.

97. MILLERITE. Sulphide of Nickel.

This mineral is brass-yellow, resembling chalcopyrite. It is not a common or abundant mineral, and in California has been observed only at one locality—No. 3958, found half a mile from Cisco, Placer County.

98. MINERAL COAL. Lignite, Anthracite, Ionite, etc.

COAL—ITS OCCURRENCE IN CALIFORNIA AND ELSEWHERE ON THE PACIFIC COAST—PRODUCTION, CONSUMPTION, PRICES, ETC.

Possessing important minerals in great variety and abundance, California has not yet shown such wealth of coal as is much to be desired and as it is to be hoped the future will reveal. Deposits of this fuel occur at many places in the State, some of them being quite heavy, but none consisting of the better varieties of coal. Our coal is a lignite, answering very well for making steam and for domestic uses, for which, being comparatively cheap, it is largely employed. But thus far there has been found in the State no anthracite, coking, or even first class bituminous coal. Our domestic supplies have from the first been nearly all obtained from the Mount Diablo mines, which, opened up in 1860, have since turned out a yearly average of about 100,000 tons.

WHAT WE PAY FOR COAL.

The fossil fuels are among the staples for which we have always been obliged to pay high prices, whether required for forging iron, making gas, generating steam, cooking our food, or warming our houses. For whatever purpose employed this fuel has sold in the San Francisco market at an advance of nearly 100 per cent on eastern prices. Where the consumer almost anywhere east of the Mississippi has had to pay from $4 to $6 per ton for coal, we have had to pay for a like article from $6 to $13; the rates ruling at present and which have for some time past obtained in this market being shown by the following table:

	October, 1882.	October, 1883.
Australian	$6 25	$7 25
Liverpool	6 75	7 25
West Hartley	7 50	8 25
Scotch Splint	7 00	8 00
Lehigh	12 50	13 00
Coos Bay	6 50	7 50
Seattle	6 75	7 50
Mount Diablo	6 50	7 50
Wellington	9 00	10 00

With us the price of foreign coal depends somewhat upon the amount of shipping required for carrying away our wheat crop. If this be large, vessels coming here to load with wheat, in the absence of other lading, bring coal at low rates, taking it sometimes as ballast. Not always, however, have these low freights inured to the benefit of the consumer, local dealers combining very often to control the market and so keep up prices.

WHERE WE OBTAIN OUR SUPPLIES.

With the exception of some small lots taken from mines in the interior of the State, we procured our supplies of coal for the two years stated from the sources and in the quantities below set forth:

Where From.	1883. Tons.	1882. Tons.	Increase. Tons.	Decrease. Tons.
Foreign.				
Australia	150,318	158,901	----------	8,583
English and Scotch	155,102	188,771	----------	33,669
British Columbia	117,822	157,762	----------	26,994
Eastern.				
Anthracite	26,725	24,996	1,729	----------
Cumberland	16,555	14,860	1,695	----------
Domestic.				
Mount Diablo	76,162	113,255	----------	37,093
Coos Bay	24,525	14,533	9,992	----------
Seattle	164,986	154,611	10,355	----------
Carbon Hill (Tacoma)	137,420	54,627	82,793	----------
Chili	----------	580	----------	----------

California's consumption of coal the current year will be somewhat larger than that of 1883, owing to various new industrial establishments having been started, some requiring it for furnaces and forges, and nearly all for making steam. The supplying sources continue the same, with an enlarged production from the British Columbia, the Carbon Hill, and the Coos Bay mines, and a falling off in the product of the Seattle mines; the Mount Diablo showing the same output this year as last. Our importations of coal from Australia, the United Kingdom, and the Eastern States have been much less thus far the current year than usual. We append table showing receipts at San Francisco during the first six months of 1884:

Where From.	Tons.
Australia	49,345
English, Scotch, and Welsh	42,843
British Columbia	60,000
Eastern (Anthracite and Cumberland)	16,445
Seattle	65,318
Carbon Hill (Tacoma)	74,835
Mount Diablo	38,000
Coos Bay	37,596

The diminished receipts of foreign coal, as above shown, have been due to the following causes: Australia has this year a large wheat crop to move; hence, few vessels have arrived at this port from that country bringing coal. The dry weather that prevailed early in the year having threatened California with a short wheat crop, English ships, the usual carriers of coal, were deterred from coming here to load with that cereal; as a consequence, we are without our usual supply from that source, with prices meantime well maintained. More favorable weather later in the season having insured us an abundant yield of wheat, fleets of vessels will be attracted here from abroad, bringing, no doubt, their usual complement of coal. The prospect, therefore, is that the prices now ruling for the foreign article will recede before the year is ended.

THE COAL MINES OF CALIFORNIA—THE MOUNT DIABLO GROUP.

The only coal mines in California that have been worked to any extent and with even the smallest profit, are those included in the Mount Diablo coal field, a belt extending for ten or twelve miles along the northerly slope of Mount Diablo. All the mines, however, that have here been profitably worked, are included in a section of this belt, reaching not over two and one half miles along its western portion, and extending from the workings of the Black Diamond to those of the Pittsburg Company. The principal veins here consist of two, the Black Diamond having forty inches of coal, and the Clark having thirty-four inches, two small veins, the one having about a foot and the other five or six inches of coal, lying between them. Several other seams traverse the formation, but they are all too small to be of any value. While a great deal of money has been expended in this region prospecting for coal, only in a few instances have deposits sufficiently heavy been developed to warrant their being worked. The only companies that are now making, or ever have made, any considerable production here, are the Black Diamond and the Pittsburg, there being one or two others that are at present operating in a limited way. The Eureka, the Independent, the Union, the San Francisco, the Peacock, and the Stewart, or Central, are all among the mines that have been extensively exploited, but to so little purpose that work was suspended upon them many years ago. Since then, the most of them have filled with water, and having been dismantled, may now be considered practically abandoned. The developments made in the Empire and the Rancho de Los Maganos, are such as have served to keep life in these properties, which will ultimately, no doubt, be brought into a productive condition.

The trouble with these Mount Diablo mines is twofold—the coal, in the first place, is of an inferior quality, and then the cost of extraction is great, the beds being small and much disturbed by faults and dislocations. Mr. W. A. Goodyear, who several years since examined these deposits with great care, in remarking on this feature, observes that within the two and one half miles of profitable working, some seven or eight faults of considerable extent occur, involving throws of from ten to one hundred and fifty feet each, while immediately outside this section are disturbances of still greater magnitude, lesser but well marked dislocations being extremely numerous in these mines. The cost of mining and placing this Mount Diablo coal in San Francisco has averaged at least $5 per ton of 2,240 pounds, the cost of mining alone having averaged over $3 per ton.

The following table shows yearly receipts at San Francisco of coal from the Mount Diablo mines, from the time they were first opened to date, the quantity received during the first six months of 1884 being estimated:

Years.	Tons.	Years.	Tons.
1860	-------	1873	171,741
1861	6,620	1874	206,255
1862	23,400	1875	142,808
1863	43,200	1876	108,078
1864	50,700	1877	96,172
1865	60,530	1878	122,034
1866	84,020	1879	134,435
1867	109,490	1880	158,723
1868	132,537	1881	114,000
1869	148,722	1882	102,356
1870	129,761	1883	76,162
1871	133,485	1884 (first half)	38,000
1872	177,232		

Adding to the above ten per cent for coal sent from the mines to other points than San Francisco, and fifteen to twenty thousand tons to represent output of the Ione, Lincoln, and various other small mines in the State, we have the total product of the California coal mines up to this time; the other sources from which we have been accustomed to obtain our supplies of this fuel being sufficiently indicated by the tables already given.

OTHER DEPOSITS IN THIS STATE.

Of the other localities in California at which coal or lignite deposits have been found, outside of the Mount Diablo field, the following may be noted: In Ione Valley, Amador County, where the bed, which lies near the surface and can be easily worked, varies from five to fifteen feet in thickness. Although this deposit was discovered prior to 1870, and worked in a small way for several years thereafter, not until 1877 was much coal taken out, the product that year having amounted to 3,458 tons. From that time on not much was done here until 1883, when the mine began to be again actively worked, from forty to sixty tons per day having since been extracted. While this coal has been found to answer for making steam for general purposes, it does not answer for locomotives, the Central Pacific Railroad Company, after a trial of it on their engines, having discontinued its use. That company several years ago constructed a railroad from Galt to these mines, a distance of twenty-two miles, in the expectation that this coal could be used to advantage on their locomotives. Through its failure to do so the company sustained a heavy loss. All the coal now being taken out at this place finds ready sale at remunerative prices, being used by the flouring mills and other industrial establishments in the vicinity, and also to some extent on the steamers running on the Mokelumne, Sau Joaquln, and the Sacramento Rivers.

Shortly after the opening up of this Ione bed a similar deposit of coal was discovered at the town of Lincoln, in the southwestern part of Placer County. After some attempts at working this deposit operations were suspended, the coal proving to be of very poor quality. After remaining idle for some years, a new shaft was put down, which not only developed a thicker vein but a better quality of coal. Since this strike several carloads have been taken from the mine daily. Though a rather poor article, it finds a market, as it answers tolerably well for making steam and as an ordinary fuel. The owners are sinking a third shaft on the vein, with a view to facilitating the work of extraction. This mine is favorably situated for shipping its product, being within a few hundred yards of the California and Oregon Railroad.

More than twenty years ago a coal field was discovered and partially explored at Corral Hollow, in the hills to the south of the Livermore Pass. Many shafts were sunk, tunnels driven, and much money expended here, without developing any valuable bodies of coal, and the locality has for many years past been abandoned. At the time these deposits were being actively explored, the Western Pacific Railroad Company laid down a track from Ellis Station to the mouth of Corral Hollow, in the hope of being able to get coal here for their locomotives; a hope in which they were disappointed.

RECENT DISCOVERIES MADE AND REPORTED.

Among recent discoveries of coal in this State is the deposit known as the McIntosh and Cheney mine, situated in San Diego County, 4½ miles from Laguna Station, on the California Southern Railroad. The developments made here consist of a tunnel started on the easterly slope of the mountain in which the deposit occurs, and which, when 40 feet in, struck a vein of lignite 4½ feet thick. This tunnel was carried forward 206½ feet further, all the way in a bed of coal, which at this point measured 7 feet 3 inches in thickness, being of uniform quality and solid throughout. As this tunnel was advanced samples of the coal were taken for assay, one of which was made by the State Mineralogist. These assays showed it to contain, of fixed carbon, from 35.35 to 46.82; volatile matter, 30.40 to 40.27; water, 10 to 23; ash, 5.36 to 11.25; this being very similar to the Mount Diablo and Coos Bay coal. Several hundred tons of it sold at the mouth of the tunnel, to consumers in the neighborhood, is said to have given general satisfaction. As it can be broken out readily and without the use of powder, one man extracting several tons per day, it is sold at low prices. Thus far the cost of mining this coal has been $1 50 per ton; but with better facilities for performing the work, it can probably be delivered at the mouth of the tunnel for a third of that sum. Should this find turn out as well as expected, it will prove of great advantage to that section of the State, which, scantily supplied with wood, has still large fuel requirements, which have heretofore been met in good part by coal brought from British Columbia and Puget Sound. An ample supply of good coal from local sources would be to Southern California a matter of great economic importance.

A vein of coal 6 inches thick was discovered last year at a point about 25 miles from the town of Bodie, Mono County. Tested in the miners' stoves, this coal is represented to have burned freely with a steady flame, throwing out much heat. The deposit occurs in a sandstone formation, and though not yet opened up to any extent, is spoken of hopefully by parties who have seen it. The country in the vicinity abounds with mines, and being but sparsely wooded, the discovery of a tolerably good coal, even in moderate quantities, would help its prospects very much.

The finding of encouraging coal signs about four miles from Fulton Wells, Los Angeles County, was announced not long since. Though not yet developed, this find is said to be one of much promise; the vein discovered being several feet thick, and consisting of a bituminous coal, that burns freely in an open grate. Indications denote for this bed a considerable extent, a similar outcrop appearing across the range south of Spadra, seven miles distant. This would carry it through the rolling Puente hills, affording excellent facilities for opening up the bed, and giving a railroad near to and on each side of it. The work of further exploring this deposit will be awaited with interest.

Coal signs, and in somes cases deposits of considerable extent, have been met with at many other places in California; but only on a few of these has much exploratory work been done. In good time they will all be examined with more care, resulting, no doubt, in greatly enlarging our stock of the fossil fuels.

According to Mr. Goodyear, already quoted, a bed of coal, from 14 to 15 feet in thickness, has been exposed on the Middle Fork of Eel River, eight miles south of the village of Round Valley, in Mendocino County. While this coal occurs here in such quantity, and is of good quality, Mr. Goodyear expresses the opinion that very little of it will ever be likely to reach the San Francisco market, for the reason that the rocks in the neighborhood have been so much disturbed, that the bed will probably prove to be much crushed and broken up by faults; while the locality, being in the heart of the Coast Range, could be reached only by a railroad for a long distance over a rough country. In addition to the above, veins of coal, generally of sufficient thickness to suggest for them some value, have been observed at the following localities in this State, viz.: In the hills south of Vallecitos, 6 miles westerly from the New Idria quicksilver mines, Fresno County; on Los Gatos Creek, easterly flank of the Coast Range, same county; in the foothills of the Sierra Nevada, eastern part of Shasta County, where the coal outcrops over a considerable area; at American Cañon, in the southwestern part of Solano County, along the face of a steep bluff; the coal signs here not, however, being in place; in the range of hills east of Santa Rosa Valley, Sonoma County; and at many places in the Coast Range besides those mentioned; the most encouraging indications being met with in Santa Cruz, Monterey, Alameda, and Contra Costa Counties, coal signs having been reported one time and another in almost every county in the State. A table of approximate analyses of California lignites is given on page 14 of this report.

ELSEWHERE ON THE PACIFIC COAST—THE COOS BAY FIELD.

A coal-bearing territory of considerable extent skirts the easterly shores of Coos Bay, in the southwestern part of Oregon. A great deal of money was expended some ten or twelve years ago in opening up these mines, and in constructing railroads, wharves, and coal bunkers, for transporting their product to and receiving it at tide water, and in providing vessels for carrying it thence to San Francisco, where for several years the receipts of coal from that quarter were quite heavy. Latterly, however, and for reasons not generally understood by the public, they have been comparatively light. Again they appear to be on the eve of being increased, certain movements recently made, by the owners and others interested in these coal fields, indicating a purpose on their part to work them once more on a large scale. The Newport, formerly one of the active companies at

Coos Bay, and still large owners there, have contracted with the Union Iron Works, of San Francisco, for the construction of a large steel steamer, to run between that port and their coal mines. Another steamship, lately launched at Marshfield, on Coos Bay, has been brought to San Francisco to receive her machinery, built at the Fulton Iron Works. Being named the Coos Bay, this vessel is presumably intended for the trade between this city and that point. It would look as if these mines ought to be more largely worked than they have been of late, as they have been pretty well opened up, supplied with extensive plant, and lie convenient to navigable waters.

WASHINGTON TERRITORY.

In this Territory occur the most extensive and, at present, largely productive coal fields on the Pacific Coast. The output here will probably be greater this year than it was last, although the Seattle mines show for the first six months of the year a decline that is not made up by some slight increase at Carbon Hill. It is anticipated, however, that the output at both these places will be larger for the last half of the year than it was during the first half. Owing to a fire that occurred in the Bellingham Bay mines several years ago, destroying the plant and underground works, they have not been worked since, though known to contain a large body of good coal. These mines are situated in the extreme northern part of the Territory, close to the British Columbia line, and on the westerly verge of an extended coal field.

The Seattle coal is a lignite from the Newcastle and the Renton mines, the former located twenty and the latter thirteen miles easterly from the town of Seattle on Puget Sound; this coal taking the name of the town for the reason that it is shipped at that port. Both of these mines are connected with Seattle by rail, a wharf having capacity to put 2,000 tons of coal per day on shipboard having been built at that place. The owners of these mines have provided a large fleet of steam and sail vessels for carrying their product to San Francisco where they have capacious depots for receiving and storing coal.

The Carbon Hill mines are situated on Carbon River, 32½ miles northeast of Tacoma, on Puget Sound, where this coal is shipped and therefore often called Tacoma coal. These mines belong to the Pacific Improvement Company, who have a line of powerful steam colliers for transporting their product to San Francisco Bay, where extensive bunkers have been built, and whence it is distributed as required by the locomotives and steamers of the Central Pacific and the Southern Pacific Railroads, which consume the most of it. There are three veins being worked at Carbon Hill, one having a thickness of 17½ feet, one of 6, and one of 4½ feet. They are worked through a tunnel above the level of which there is estimated to be a very large quantity of coal. This has been pronounced by experts a good bituminous coal, hard and clean and superior to any found elsewhere on the coast, though not equal in heating capacity to the best Pittsburg. It is also claimed that this coal can be coked to advantage. About 250 men are employed at these mines on wages varying from $2 75 to $3 per day, boarding themselves. Some work by the piece, receiving from $2 to $3 per cubic yard broken out. At the Seattle mines about an equal number of men are employed and on similar terms, the prices paid workmen in the California coal mines being a little less than in those of Washington Territory.

OTHER COAL FIELDS WEST OF THE ROCKIES.

In Arizona, Utah, British Columbia, and Alaska, coal is known to exist, the quantity in some of these countries being large. The British Columbia mines, which are quite extensive, contribute largely towards supplying the wants of California, the best coal yet obtained on the coast coming from these mines. Judging from the small lots from that country that have come to hand, Alaska also affords some excellent coal.

Several years ago the Central Pacific Railroad Company, who own extensive deposits of coal in Wyoming Territory, having opened them up at much expense, made a determined and somewhat costly effort to employ the product of these mines for their own use, and also introduce it on the San Francisco market. Though an excellent coal for many purposes, railroad transportation for more than a thousand miles proved too expensive to warrant a continuance of the effort. As a result, there has been received at San Francisco during the past twelve years or more very little of the so called Rocky Mountain coal, though the above company have all the while used some of it on the eastern portion of their road, and will continue to do so, increasing, very likely, the quantity consumed in the future.

According to late reports, an extensive coal field has been discovered in the northeastern part of Arizona. Samples brought from that quarter show this to be a good quality of coal, and the find will be of great importance should the deposits prove to be large and permanent.

A SIMPLE METHOD FOR TESTING THE QUALITY OF COAL.

The following is the substance of a paper prepared by Melville Attwood, describing simple and effective means devised by him for determining the different varieties of coal, this paper having been read by the author before the California Academy of Sciences, June 2, 1884. The method of procedure in making these tests, as described by Mr. Attwood, is as follows: Having procured a streak plate of hard porcelain, work a smooth even surface upon it with a fine emery file, using water with a little washing ammonia in it. This done, paste letters on the margin of the plate to designate the different samples of coal to be tested. Select a piece of coal free from decomposition, earthy or other extraneous matter, and, rubbing it gently on the plate, compare the streak made with the known varieties, the plate being so moved that the rays of light will fall on the streak from different directions. To facilitate the process of rubbing, it may be performed through small slots cut in a piece of cardboard laid on the plate. By the above means the character of a coal can, in Mr. Attwood's opinion, be determined with considerable accuracy, the better varieties giving a blackish, while the inferior give a brownish streak. The former contain but a small amount of combined water, while the latter contain it in excess.

Remarking further on the examination of different kinds of coal, Mr. Attwood quotes from Crooke's Metallurgy to the effect that the nature of this fuel can often be judged of by its external appearance; a full black color, lively luster, and great hardness, indicating the presence of much oxygen, while a pitch-like luster shows a small, and a glassy luster a somewhat larger amount of carbon. A black color, strong luster, slight coherence, and little tenacity, denote a large amount of carbon with more hydrogen than oxygen. A brownish black color, dull appearance, strong coherence, and a certain hardness, show little carbon with more oxygen than hydrogen. The entire paper will be published in the proceedings of the society.

The wasteful consumption of coal in open grates and under boilers, is the subject of an article in one of the scientific journals, in which Mr. Weldon, a well known English chemist, is quoted as saying that it is difficult to insure the complete combustion of coal, even in making a chemical analysis, and in the open grate it is impossible. By dry distillation, he says, a ton of coal can be made to yield twenty pounds of ammonium sulphate, worth eighty cents, and the soot that lodges in the chimneys and defiles furniture and buildings, would yield coal tar. As a remedy for all the waste and the difficulties involved, Mr. Weldon asserts that coal should be distilled in close vessels, and all the products of distillation be collected. This being done, the gas would serve to distill fresh coal, and to work gas engines to generate electricity for light, the ammonia would be a superior fertilizer for land, the tar would be manufactured into dyes, the residuum of coke being employed for heating purposes, etc.

The approximate analysis of coal which serves all practical purposes, is made as follows:

A portion of 100 parts is pulverized and dried at a water bath heat, until it ceases to lose weight, the loss equals the percentage of water.

A second portion of 100 parts is pulverized and heated to redness in a shallow vessel exposed to the air, until a perfect ash only remains—the residue equals the percentage of ash.

A third portion, also 100 parts, in small lumps, is heated to redness in a closed vessel (a platinum crucible, with cover, is the best), until no more inflammable gases escape. The crucible must be cooled without removing the cover. This operation divides the coal into two portions, fixed and volatile; one can be weighed, and the other cannot. Subtract the weight of the coke from 100, and the loss will equal the volatile portion, including water. Example: Suppose the water to be 10 per cent; ash, 5 per cent; coke, 47 per cent. Subtract the coke (47) from 100, and the difference (53) is the volatile portion; from the coke subtract the ash, and from the volatile portion the water. The results, in percentage, will be as follows:

Fixed carbon	42
Volatile combustible matter	43
Ash	5
Water	10
	100

The gas may be conveyed into an inverted bell-glass in a pneumatic trough, and measured, if so desired.

Ionite is a hydro-carbon mineral, first described by Samuel Purnell, in the *Mining and Scientific Press* of March 24, 1877. It was first found in Ione Valley, Amador County, whence the name. The following are extracts from Mr. Purnell's description: When first found it contains 50 per cent of water, but when air dried it floats on water, the specific gravity being about .9—melts to a pitch-like mass which burns easily with a dense black smoke, having a resinous aromatic odor and with a yellow flame.

Ionite contains 13 per cent of impurity, principally silica and alumina. Streak reddish yellow, fracture irregular, luster none, when pulverized water suspends a portion of the clay in the mineral. It is partly soluble in cold alcohol, more so in boiling alcohol, giving a brown solution. On addition of water no precipitate is deposited, but the solution becomes permanently of a milky color. Very soluble in ether, forming a brownish black solution; on adding water a brown tarry substance is obtained, very inflammable, and which, while burning, gives off the odor of burning sealing wax, wholly soluble in chloroform, except the clay or ash, forming a brownish black solution; poured into water a brown oil falls to the bottom, partly soluble in cold, more so in boiling oil of turpentine, forming a wine-red solution; on concentration of the solution crystals of paraffine are separated, almost wholly insoluble in cold or boiling petroleum naphtha; subjected to dry distillation a brown tarry oil passes over mixed with green colored water.

Ionite is found in considerable abundance at the original locality, and I have found it in lignite beds in San Benito County. It will be more carefully studied in the future and will perhaps be found valuable otherwise than as a fuel.

99. MINERAL WATERS.

Springs of mineral water are quite abundant in California. The State Mining Bureau has information concerning fifty-eight springs, all of which have more or less notoriety. Nothing reliable can be given concerning them beyond what was published by Dr. F. W. Hatch.

Allusion has been made elsewhere in this report to certain minerals which exist in mineral waters, and to the importance of careful analyses and the publication of an official guide-book. This the Mining Bureau will endeavor to accomplish, if it has the needed support and means to establish the required laboratory. Samples of water from the greater lakes of the State have been obtained and placed in the State Museum preparatory to analysis.

MISPICKEL—see Arsenopyrite.

100. MOLYBDENITE. Etym. *Lead* (Greek). Sulphide of Molybdenum.

This is a soft, black, lustrous, foliated mineral, resembling graphite, for which it is frequently mistaken. It has no special value. It is rather common in California, in the granites of the Sierra Nevada, and associated with gold in the quartz veins, and frequently with copper and silver ores. According to Dana, it is found with molybdite and gold in the Excelsior mine, Nevada County. The State Museum contains several specimens. No. 4126 is from Speckerman's mine, six miles above Fresno Flat, Fresno County; No. 3748 from the Beveridge mine, Inyo County (this is foliated and was mistaken for graphite); No. 4102 from the White Mountains, Inyo County; No. 4365 from near Independence, Inyo County; No. 4454 from South Fork of King's River, fifty-five miles northeast of Visalia. It has also been met with in the Cosumnes copper mine, El Dorado County.

101. MOLYBDITE. Molybdic Acid, Molybdic Ochre.

According to Dana, this mineral is found in the Excelsior mine, Nevada County, with molybdenite and gold.

Mountain Blue—see Azurite.

Mountain Butter—see Lenzinite.

Mountain Cork—see Amphibole.

Mountain Leather—see Amphibole.

Mundic—see Pyrite.

Muscovite—see Mica.

Natron—see Trona.

102. NICKEL. See also Millerite and Zaratite.

Nickel is rather a rare metal, and is generally found associated with iron and cobalt; the same association occurs in meteorites. It is never found in the metallic state (except in meteorites), being always combined with other elements, as arsenic, sulphur, oxygen, silicon, copper, antimony, carbon, etc., as well as with iron and cobalt.

It is a silver-white, malleable, and ductile metal; sp. gr. 8.28 when cast, and 8.666 when forged.

It possesses the power of attracting the magnet, like iron; it is less fusible than iron, and does not easily oxidize, for which reason it is extensively used for plating iron and other metals likely to tarnish by exposure to air and moisture. It is also used in alloys, the most useful being German silver, composed of copper 100 parts, zinc 60 parts, and nickel 40 parts, fused together. It is also used for coin; the United States five-cent nickel coin being: copper, 75 per cent; nickel, 25 per cent; weight, 77.16 grains. The three-cent nickel coin has the same composition, weight 30 grains.

Nickel was first discovered in 1751 by Cronstedt, in a mineral called by the miners "Copper nickel" (Kupfernickel), or false copper, because although it had the appearance of being copper ore, it did not contain that metal. Kupfernickel is now called Niccolite, and is composed of nickel and arsenic. The test for nickel, even by an expert chemist, is attended with difficulties, and there is no simple, easy, characteristic test by which the prospector can identify it. The principal ores of nickel are niccolite; pale copper color, streak brownish red, brittle. When heated on charcoal, it gives off fumes of arsenic, recognized by the smell of garlic. Millerite; brass-yellow resembling chalcopyrite, gives a reaction of sulphur, but no copper. Genthite, or Garnierite; apple green in color. Silicates and arseniates of nickel have been found in Oregon and Nevada, and are likely to be found in California. Millerite and Zaratite are the only nickel minerals as yet discovered in the State, and these only in very small quantities. Dr. Trask in his first "Report on the Geology of the Coast Mountains, and part of the Sierra Nevada, 1854," refers to nickel ores, "in the coast mountains from Contra Costa to the utmost limit reached in that range, associated with chromic iron in primitive rocks. The mineral is more abundant in the serpentine rocks south of Tularcitos, and near San Antonio, Monterey County. This mineral, Zaratite, or "Emerald Nickel," will be described under the proper head.

NITRATE OF SODA—see Soda, Niter.

OBSIDIAN—see Orthoclase.

OCHRE—see Limonite.

ONYX MARBLE—see Aragonite.

103. OPAL. Etym. *Opalus* (Latin). Hyalite, Wood Opal.

Opal has the same chemical composition as quartz. Silica is demorphous, opal assuming one form and quartz the other. Opal is softer and of less specific gravity, and is never found crystallized. It is generally soluble in a hot solution of caustic potash, and usually contains water. The precious opal is very valuable, but is rare; it has never been found in California. In May, 1883, when the mineral collections of Honduras were exhibited in the State Museum, magnificent opals were included, some of which were the largest and finest ever known. Common opal has been found in several localities in the State.

A white, milky variety of opal is found in Calaveras County, at Mokelumne Hill, or on the hill near that place known as Stockton Hill, on the west side of Chile Gulch. A shaft has been sunk there three hundred and forty-five feet, and the opals are found in a thin stratum of red gravel. They vary in size from a kernel of corn to the size of walnuts. Many of them contain dendritic infiltrations of manganese oxide, looking like moss. About a bushel of these stones are raised in one day, and are said to have a market value. A white, milky variety similar to the above, and without "fire," is found with magnesite in the Mount Diablo range, thirty miles south of the mountain. Also in the foothills of the Sierra Nevada, at the Four Creeks (Blake).

This locality is represented in the State Museum by No. 4395. They are also found near Murphy's, Calaveras County (Dana), and in Plumas County (Edman). Hyalite is found at Volcano, Amador County (Dana). Associated with semi-opal in the Mount Diablo Range, about 30 miles south of Mount Diablo (Blake). Also, 9 miles northeast of Georgetown, El Dorado County. No. 1347 in the State Museum is from Kelseyville, Lake County; and No. 1514 is found plentifully in cavities in basaltic lava, Township 10 north, and Ranges 5 and 6 east, Lake County. Hyalite resembles glass, and is generally found in irregular fragments. Opalized wood is wood petrified and changed to opal. It is not uncommon in the hydraulic gold mines, in magnificent specimens.

OPALIZED WOOD—see Opal.

104. ORTHOCLASE—see also Feldspar—Common Feldspar, Potash Feldspar.

This mineral derives its name from the Greek, meaning "*straight break*," because it cleaves at right angles. It is a silicate of alumina and potash.

Silica	64.6
Alumina	18.5
Potash	16.9
	100.00

Many rocks contain orthoclase as one of their constituents. Granite and gneiss are composed of orthoclase, mica, and quartz. Granulyte, Pyroxenite, Orthoclase felsite, some varieties of Porphyry, Phonolyte, Trachyte, Obsidian, Halleflinta, and Pitchstone, contain orthoclase.

Orthoclase readily decomposes and forms soils. It is used as a source of potash; and with kaolin and quartz, in the manufacture of porcelain and pottery. Obsidian, a variety of orthoclase in an impure state, is a lava cooled quickly. The obsidians vary in composition; to all appearance they seem homogeneous, like glass, but if examined microscopically they are found to be full of minute and sometimes very beautiful crystals. Obsidian was known to the ancients, and was used for stone implements in the most remote ages, long before the commencement of history. It has the property of breaking evenly into fragments with sharp edges. The Aztecs used knives of obsidian in their human sacrifices. The word obsidian (obsidianus lapis) is said to be derived from Obsius, a Roman who first brought it from Ethiopia. According to Pliny, it was called also Liparæn, from the island of Lipari, which produced it. It was used by the Romans for mirrors placed in walls. The inhabitants of Quito, not many years ago, made the same use of it.

When first discovered, years ago, at Clear Lake, in Lake County, a company was formed to make bottles and other glassware from it, but the enterprise was of course a failure. Orthoclase is found in numerous localities in California. "In San Diego County, in granitic veins along the road between Santa Isabel and San Pasquale, associated with tourmalines and garnet; in Fresno County, at Fort Miller, in coarse-grained granite, under the edge of the lava plateau" (Blake); at Meadow Valley, Plumas County (Edman). Nos. 438 and 445, in the State Museum, are from the Yosemite Valley, Mariposa County, occurring in veins in granite with molybdenite; said to exist in veins several feet thick at Tehachipi Pass, Kern County. Obsidian is found near Lower Lake, Lake County; very fine specimens—black, gray, red, and variegated. No. 4908, State Museum, is from McBride's ranch, Mono County, and No. 4674 from near the south end of Goose Lake, Modoc County. It is also found near Mono Lake, Mono County; three miles north of Napa, Napa County; and in Inyo County, with basaltic lava. Some varieties of obsidian cut beautifully, and might be used for ornamental purposes, for paper weights, vases, bases of clocks, and similar purposes.

Osmium—see Iridium, with which it is invariably alloyed or associated.

Pandermite—see Priceite.

Partzite—see Stibiconite.

Pearl Spar—see Dolomite.

105. PECTOLITE. A single specimen was found in a bowlder or fragment at the foot of the White Mountains, near Montgomery, Mono County. Doubtful (Aaron).

106. PETROLEUM.

ITS DIFFERENT FORMS AND THE VARIOUS NAMES APPLIED TO THIS SUBSTANCE.

The term petroleum, derived from the Latin words *petra*, a rock, and *oleum*, oil, is applied to mineral oils, of whatever nature they may be, from the tar-like substance changed by inspissation into asphaltum, to the water-white liquid resulting from the distillation of the crude oils. The more liquid varieties are called naphtha; the more viscid and dark colored, mineral tar or maltha.

In this paper, asphaltum, bitumen, idrialite, and aragotite, as well as petroleum, will all be considered, as they possess many properties in common, and have probably a common origin. Petroleum is known under the several names: rock oil, mineral tar, maltha, naphtha, Seneca oil, Genesee oil, paraffine, coal oil, benzine, kerosene, benzol, british oil, gasoline, rhigoline, Barbadoes tar, etc. Asphaltum is also variously called bitumen, jews' pitch, mineral pitch, brea, etc.

WHAT THE ANCIENTS KNEW ABOUT IT.

While the existence of petroleum has been known from the earliest historic times, its extensive use for economic purposes, and its application in the arts, are of comparatively modern date. Pliny, book 2, chap. 108–9–10, makes mention of maltha and naphtha, like petroleum, liquid forms of asphalt or bitumen. Plutarch describes a lake of *inflamed naphtha*, located near Ecbatana, the modern Hamadau, a city of central Persia. It is highly probable that the fires kept perpetually burning in pagan shrines consisted of natural gas jets, or were fed with petroleum.

The following is quoted from Herodotus (Melpomene, 195):

> They add that in it (the Island of Cyraunis) is a lake from the mud of which the virgins of the country draw up gold dust by means of feathers. Whether this is true, I know not, but I write what is related. It may be, however; for I have myself seen pitch drawn out of a lake and from water in Zacynthus (now Zante), and there are several lakes there. The length of them is seventy feet each way, and two orgyæ in depth. Into this they let down a pole with a myrtle branch fastened to the end, and then draw up pitch adhering to the myrtle. It has the smell of asphalt, but is in other respects better than the pitch of Pieria. They pour it into a cistern dug near the lake, and when they have collected a sufficient quantity, they turn it off from the cistern into jars.

As the foregoing was written more than two thousand years ago, and these springs near Zante still continue productive, the permanent nature of this class of deposits is, at least in the present instance, pretty well established.

Strabo, book 16, chap. 1–15, says that *asphaltus* is found in great abundance in Babylonia, and quotes Eratosthenes as follows:

> The liquid asphaltus, which is called naphtha, is found in Susiana; the dry kind, which can be made solid, in Babylonia. There is a spring of it near the Euphrates. When this river overflows at the time of the melting of the snows, the spring also of asphaltus is filled and overflows into the river, where large clods are consolidated, fit for buildings constructed of baked bricks. Others say that the liquid kind also is found in Babylonia. With respect to the solid kind, I have described its great utility in the construction of buildings. They say that boats (of reeds) are woven (Herod. i, 194), which, when besmeared with asphaltum, are firmly compacted. The liquid kind, called naphtha, is of a singular nature. When it is brought near the fire, the fire catches it; and if a body smeared over with it is brought near the fire, it burns with a flame which it is impossible to extinguish, except with a large quantity of water; with a small quantity, it burns more violently; but it may be smothered and extinguished by mud,

vinegar, alum, and glue. It is said that Alexander, as an experiment, ordered naphtha to be poured over a boy in a bath, and a lamp to be brought near his body. The boy became enveloped in flames, and would have perished if the bystanders had not mastered the fire by pouring upon him a great quantity of water, and thus saved his life.

Poseidomus says that there are springs of naphtha in Babylonia, some of which produce black, others white naphtha; the second of these, I mean the white naphtha, which attracts flame, is liquid sulphur; the first, or black naphtha, is liquid asphaltus, and is burnt in lamps instead of oil.

PRESENT PRODUCT OF THE OLD WELLS.

Many of the petroleum springs known to the ancients have been extensively worked in recent times. From those near Baku, a Russian port on the west coast of the Caspian Sea, considerable quantities of naphtha are annually exported. Here great quantities of inflammable gas also issue from the ground. This locality was in former days visited by thousands of Guebers, or fire worshipers, who built temples on the spot in which to conduct their religious ceremonies. They are still frequented by the devotees of this faith, many of whom spend here the remnant of their days engaged in acts of devotion. James Parkerson, author of "Organic Remains of a Former World," published in the early part of the present century, shows by quotations from "Abbé Forti's Travels," in Dalmatia, and the works of Captain Cox, that no less than 26,000,000 gallons of petroleum were, even at that early period, shipped annually from this port. This oil is exported largely to Persia, in portions of which it is the only material used for producing artificial light. These Baku deposits occur over a tract 25 miles long by half a mile in width. The oil here is gathered in wells sunk from 16 to 20 feet in the porous sandstone. That obtained near the center of the tract is quite clear, but the material grows thicker and darker as the edge of the deposit is approached, until it finally hardens into asphaltum.

From the Rangoon district, in India, a large portion of that country and the whole of the Burman Empire are supplied with rock oil, which occurs here, and is collected in much the same manner as above described. As at Baku, these Rangoon wells have been yielding since the earliest times.

KEROSENE AND COAL OIL.

Although the attention of the Royal Society of London was as early as 1739, called to the fact that in making gas from coal, a black oil was left as a by-product, no practical results came of it, and it was left for the French to first distil coal oil from bituminous shales. In 1847, Dr. Abraham Gesner obtained from Trinidad, asphaltum oil and naphtha. This oil he burned in lamps during a lecture given by him in Halifax. He had the year before commenced making oil from Prince Edward Island coal. The first patent for distilling oil from coal was, however, granted to the Earl of Dundonald, in 1781. In 1850, James Young, a chemist, of Manchester, England, patented a process for obtaining paraffine oil from coal, and four years later began manufacturing it largely.

In 1854, Dr. Gesner procured a patent for making kerosene oil, an article so named from the two Greek words *Keros*, wax, and *Elain*, oil. Camphene being at the time a well known burning fluid, this word was added to *Keros*, and from the new term the word *Kerosene* was formed. The first mineral oil manufactured in the United States was made by Dr. Gesner, in 1854, at the works of the New York Kerosene Oil Company, on Long Island.

The production of coal oil was at one time quite large in the United States, there having been no less than fifty-six works engaged in its manufacture. The following was the method pursued in making it: A quantity of the crude oil, having been distilled off roughly, was submitted to fractional distillation, after which the product was treated by sulphuric acid, whereby the dark maltha was thrown down, the acid was then neutralized by excess of caustic soda, and the clean portion thoroughly washed with water, to remove both the acid and alkali. The fluids were then either sold as they were or again distilled, this depending on the quality required. The production of coal oil, though discontinued in the United States, is still carried on in some other countries, there being no less than sixteen companies engaged in the distillation of coal oil from shale in Scotland. Where practicable, the business is deserving of encouragement, both as a means of utilizing what in many localities is a cheap and abundant material, and of economizing our petroleum resources, which we are exhausting at a rapid and in some instances reckless rate.

A ton of Virginia cannel coal yields products as follows:

Kerosene	25 gallons.
Lubricating oil	10 gallons.
Naphtha	10 gallons.
Paraffine	10 pounds.
Ammonia	10 pounds.
Carbolic acid	10 pounds.

And usually from 1,000 to 1,200 pounds of coke.

The time will very likely come when coal, petroleum, asphaltum, and the bituminous shales will be retorted into gas and coke; the former to be employed for both heating and illuminating purposes and driving gas engines, and the latter as a clean and economic fuel, being used, perhaps, under the very retorts by which it is produced.

EARLY HISTORY OF PETROLEUM IN THE UNITED STATES—FIRST BORINGS AND RESULTS.

The Indians inhabiting portions of southern New York and central Pennsylvania had a knowledge of the petroleum springs that exist in that region, and were in the habit of using the crude oil as a liniment long before the country was settled by the whites. At a later day the Indians, collecting this substance, sold it to the settlers, under the name of Seneca or Genesee oil.

As early as 1847 James Young, the Manchester chemist before mentioned, experimenting on a shaly coal taken from a mine in Derbyshire, succeeded in obtaining therefrom an excellent lubricating oil. The success of this experiment laid the foundation of the business of refining and preparing the crude mineral oils, which has since grown to such vast proportions in this country.

In 1857 Bowditch & Drake, of New Haven, Connecticut, commenced the business of searching for oil, which they proposed to refine and sell.

In 1858–9 Col. E. L. Drake commenced boring in the bed of Oil Creek, Pennsylvania, where, on the twenty-sixth of August, 1859, he struck oil at a depth of 71 feet. This oil rose in the pipe to near the surface, and by pumping 400 gallons per day were obtained, which quantity was finally increased to 1,000 gallons. Encouraged by this success, many other parties at once commenced boring, and so rapidly were these efforts multiplied, that there had within a year been sunk in this section of the State no less than 2,000 wells, 74 of which yielded daily enough oil to fill 1,165 barrels, of the capacity of 40 gallons each—46,600 gallons.

Following the grand results so reached in Pennsylvania, the business of boring for or otherwise searching after coal oil was actively engaged in throughout many parts of the world; deposits already known to be productive having in many cases been more fully utilized, while new ones were diligently sought after. While these efforts were in most cases attended with disappointment or only a partial success, they have, nevertheless, led to many important discoveries and a great expansion of the known oil-bearing territory of the world.

ORIGIN OF PETROLEUM.

It must be admitted that the origin of petroleum and the mineral hydro-carbons is unknown. New theories are continually being published bearing on this subject. For many years it would have been a geological heresy to deny that beds of coal were formed during the carboniferous age from vast accumulations of trunks of tropical trees, and other vegetable matter. When enormous petroleum deposits in the United States and other countries were discovered, this came to be doubted, and it began to be suspected that both coal and petroleum had a common origin. The opinion obtained that petroleum was first formed, and afterwards changed into coal, asphaltum, and other bituminous substances, while some believed that petroleum resulted from coal. Oil had already been distilled from coal and called coal oil. Opinion was divided, some thinking that petroleum was the result of some change from coal, as obtained from artificial distillation, while others held that petroleum might have been the original form and that coal was secondary. Among the numerous theories advanced on this subject the most important ones only will be mentioned. The generally admitted theory of the origin of coal has been mentioned. Prof. T. Sterry Hunt thinks petroleum was derived from limestones, rich in marine corals. In the Report of Geological Survey of Canada, from commencement to 1863, folio 521, it will be found stated that in the birdseye formation at the Rivière à la Rose, Montmorenci, petroleum exudes in drops from fossil corals. J. P. Lesley and others have thought that petroleum has been derived from the decomposition of great accumulations of seaweed at the bottom of ancient seas, covered with sediments so heavy that the pressure caused by their weight was an important factor in the change. An examination of the sedimentary rocks exposed in Pico Cañon and at Los Angeles would lead to the opinion that some similar cause produced petroleum in California. Professor Whitney has suggested that the infusoria and diatomacea, the remains of which are so abundant in the State, may have produced the petroleum. Professor J. S. Newberry refers the petroleum and carbonaceous matter in the shales of Pennsylvania to the cellular tissue, which was abundant in the waters in which the sediments were formed.

Those who have frequently crossed the Gulf Stream and observed the vast quantities of floating seaweed, would be free to admit that not only possibly but probably the sedimentary beds now forming in the gulf, near the mouths of the Mississippi, might, when elevated above the sea level, at some future period, contain petroleum, and resemble the sedimentary rocks of the California seacoast before mentioned.

Another theory bearing on the organic origin of the bitumens is, that the bodies of mollusks, the shells of which are found fossil in the sedimentary rocks, contributed to the bituminous deposits of the present day.

It was, to be sure, a bold man who first proposed the theory that the elements carbon and hydrogen combining in the early life of the world, produced, directly or indirectly, petroleum and mineral coal. But geologists now dare to discuss these theories, and are willing to admit that the truth is not yet known.

Daubre and Bertholot have expressed the opinion that carbon and hydrogen may have united without the intervention of animal life at some period of the earth's history when conditions differing from those of the present time made this possible. Mr. A. Jaquith, in a very interesting paper in the *Overland Monthly*, December, 1874, vol. 13, folio 503, has expressed this opinion, or rather suggested this theory, and others have advanced the same idea, based upon observations made by them.

The following is an extract from a newspaper giving the substance of an article published in the *Revue Scientifique* in 1877, three years after the publication of Mr. Jaquith's paper:

THE ORIGIN OF PETROLEUM.

At a recent meeting of the Chemical Society of St. Petersburg, Professor Mendelijeff sought to combat some of the old notions on the origin of petroleum, and to substitute a new theory on the subject. It has been maintained by many geologists that the decomposition of mineral matter in the lower strata of the earth was the source of petroleum.

Mendelijeff believes that the true source is to be found much lower down. The sandstone in which it is found was not its original source, as is shown from the fact that no carbonized animal remains are found in it. There ought also to be other products of animal decomposition, if that was the starting point; we must search lower down, even below the silurian, as the mineral oil in the Caucasus is found in the tertiary, and in Pennsylvania in the devonian and silurian. As, however, in the rocks below the silurian there was very little organic life, the formation of such a great quantity of petroleum could scarcely be traced to such a limited source. Mendelijeff therefore proposes a substitute for the organic theory. He goes back to the nebular hypothesis of Laplace, and applies Dalton's law of the original gaseous condition of the material of the earth, and, taking into consideration the density of the earth and the vapor density of the elements, he arrives at the conclusion that the interior contains many metals, and that chief among them is iron; finally, he assumes the presence of carburetic compounds of the metals, and comes to the following conclusions: Through some of the fissures in the crust of the earth, occasioned by the upheaval and depression of the surface, water percolated to the carburetted metals, and acted upon them at high temperature and elevated pressure, thus forming metallic oxides and saturated hydro-carbons; the latter rose in the form of vapor to the upper strata, where they condensed to liquids in porous sandstones and other rocks having a tendency to absorb liquids. The internal heat of the earth occasioned the reduction of carburetted metals, and this gave rise to hydro-carbons. Other chemists than Mendelijeff have shown, experimentally, that something very like petroleum can be produced artificially by imitating in the laboratory the process above described.

The geological age of rocks seems to have no bearing on the origin of petroleum. It is found in the tertiary in California and elsewhere, silurian in Canada, and lias in England.

PROSPECTING FOR OIL.

The only satisfactory way to prospect for oil is to sink holes in the ground; the superficial method of making open cuts or tunnels in

California has never resulted in producing it in sufficient quantity, or of the desired quality. All the early failures were owing to this mistake, but they have led the way to an understanding of the nature of the deposits, and made it worth while to invest capital in the drilling of proper wells, and the experience made during the early developments, or rather experiments, while disastrous to individuals, has been a benefit to the State. The improved tools now used for sinking oil wells are so nearly perfect that improvement to any great extent seems impossible. The 65 foot derrick, the improved engine, the iron casing to prevent the surface water from entering, the magnificent tools weighing 2,000 pounds, or thereabout, the ingenious appliances for driving the casing, or drawing it out, if required, the sound pump, the seed bag, the dynamite blast, the system of tanks, and the device of pumping through pipes from the wells to any distant point, instead of hauling as formerly practiced, are the outgrowth of the experience made in the Pennsylvania oil fields. By the improved method of drilling, 70 feet in depth per day can be averaged, and prospectors can afford to sink a number of wells, if even one only produces oil. The old method first practiced in California, was known as the spring-pole system. The spring-pole acted like the old fashioned well-sweep, the derrick was 25 to 30 feet high, and the operation was conducted by two men. The depth attainable was from 300 to 400 feet. What is known as a spring-pole well is one sunk by this method; the diameter of the bore was generally two to two and one half inches, the modern well is eight inches at the surface, but diminishing with the depth. The favorable indications met with in sinking oil wells are the escape of gas, flow of salt water, and the appearance of oil in thin iridescent skims on the surface of the water pumped from the well. The borings are sometimes tested by being placed in a small retort, which, if put on the fire and strongly heated, a gas escapes from the end of the pipe, which may be ignited, or a drop of oil appears. This experiment is sometimes made in a common tobacco pipe.

CHEMISTRY AND ASSAY.

Petroleum seems to be a natural mechanical mixture of many hydro-carbons, each having a specific gravity, boiling point, and vapor density; proportion of the elements, from $C_2 H_6$ in gaseous form to $C_{30} H_{62}$; having a specific gravity of .890. These hydro-carbons are separated by fractional distillation, as follows: The crude oil is placed in a suitable retort, provided with an ample cooling apparatus (on a large scale this is described under Refinery). The whole volatile portion is driven over into the receiver. There is generally a residue left in the retort; the percentage is calculated, the retort cleaned, and the fluid returned to it. A gentle heat is then applied, and a certain portion—say a tenth of the whole—is distilled over; the distillate is poured off, or the receiver changed, the heat slightly raised, and a second tenth distilled off. This is continued until ten portions, each distilled at a higher temperature, have been obtained; or a thermometer is placed in the retort, and all the portion which comes off at a certain heat kept separate from that obtained at a different temperature. The works on chemistry give tables of the temperature at which each of the many hydro-carbons volatilize. By care in manipulation any one of the group may be obtained. Asphaltum and the bitumens contain oxygen. The hydro-carbons are grouped by Dana as follows: Simple hydro-carbons, oxygenated hydro-carbons, acid hydro-carbons, hydro-carbon compounds; which latter include asphaltum, and mineral coal, and unclassified species. The chemistry of the hydro-carbons is extremely complex, and it would be out of place to elaborate upon it here. A list of books of reference is given, to which the reader is referred.

Burning oils are tested by the following method: No petroleum or coal oil is safe to use that can be lighted with a match. To make this test, pour out a very small quantity, say a tablespoonful, into a saucer; remove the can to a safe distance, and then, with a lighted match, attempt to light the oil in the saucer. If the oil is safe, it will quench the flame like water. If the test is repeated for a number of times, the oil will become hot and will ignite. If it does not ignite the first time, it may be considered comparatively safe. If it should ignite, it is dangerous and should never be used for illuminating purposes.

When coal oils are gradually heated, a point of temperature will be reached when they will give off vapor; at this time, if a lighted match is applied to the surface, a slight flash will occur, but the oil itself will not inflame. If the heat is increased sufficiently, the oil will burn on applying the match. A thermometer, the bulb of which is immersed in the oil, will indicate the temperature at which the oil will flash or burn. This is what is known as the fire test. If an oil is too heavy, it will not burn well in lamps; if too light it is dangerous to use. An oil is considered safe that flashes at 100° Fahrenheit or higher, and burns from 110° to 150°. The report of Professor Chandler on this important subject, with drawings of the apparatus used in testing oils, may be found in the *American Chemist*, for August, 1872.

USES.

Petroleum and asphaltum are extensively used as fuel, and this application is daily becoming more general. Many improvements have been made in coal oil domestic cooking stoves.

Mr. J. D. Bodwell, of San Francisco, has applied it to heating large French ranges. A tank of crude petroleum, said to be *mixed with water*, is placed at some distance, which is connected with the range by a quarter-inch iron pipe, furnished with globe valve for shutting off and on. The fluid escapes into the fire chamber in a small jet, which impinges on loose fire-brick. I have seen the apparatus in operation in Eddy Street, and it worked well and was effective. The Electric Light Company, of Los Angeles, uses four to five carloads of crude Pico Cañon petroleum per month for fuel. Their apparatus is the same as that described under the head of "Refineries." Petroleum is used for burning lime at Colton, and experiments have been made, with partial success, in burning brick. The following is from a California newspaper, published January, 1879, alluding to the oil well at Little Sespe, Los Angeles County:

With this mineral oil in such abundance, it would probably soon supersede coal and wood as a steam generating fuel, Captain Roberts, Superintendent of the Los Angeles company, using it successfully in the furnaces at the well. Four barrels of crude oil go as far as two and a half cords of good live oak wood. This oil the company can, and, in fact, proposes to furnish in any quantity at one dollar per barrel. The gas companies of the larger cities will also, it is thought, substitute petroleum for coal, as there is more gas in a barrel of this substance than in a ton of coal. Schooners can be so constructed as to carry oil in tanks, which may be filled from pipes on the wharf, or it can be carried cheaply as ballast. After the burning fluid comes the lubricating oil, which is graded from the finest used on sewing machines, etc., down to car axles and wagons. It is in use on the Central Pacific road, and the "Star Oil Company" is supplying some large establishments in San Francisco. The refuse is used for fuel.

Brea (crude asphaltum) is used in California with considerable success, notably by Lankersheim & Co., at the Los Angeles flour mills, in wide grate bars with wood. Mr. Joseph D. Lynch, editor of the *Los Angeles Herald*, has used brea with wood in stoves to his satisfaction. The following is from an eastern paper:

PETROLEUM AS FUEL FOR THE RUSSIAN BLACK SEA FLEET.

It is well known that for some years the boilers of the Russian vessels in the Caspian Sea have been constructed for the consumption of naphtha refuse. Since the opening of the Baku, Tiflis and Batoum Railway the transport of this material to the coast of the Black Sea has been greatly facilitated and reduced in cost. It has, therefore, been decided to use it as fuel for the Black Sea fleet, and great advantages, both in effectiveness and cheapness, are expected to be secured. It is stated that the refuse can be delivered at Batoum at a cost of one shilling and seven pence per hundred weight, and as its heating power, compared with that of the best steam coal, is as three to one, the advantage of its employment is obvious. During the present season trials of this fuel will be made on several torpedo boats, for which class of vessels it is considered especially suitable. The necessary alterations in the furnaces, etc., will be made by Messrs. Nobel & Co., who have large petroleum refineries in Baku, and have already altered several of their own steamers with a similar object.

The Standard Hydro-Carbon Fuel Company of Boston claim to melt iron and copper, and reduce gold, silver, and zinc ores by their process. I have myself seen in San Francisco ores perfectly roasted by simply dropping through a cylinder heated by petroleum blown in with a jet of steam.

As a paint.—In 1867 a barn was painted with crude petroleum mixed with Ohio so called fire proof paint. After six years it was found to be well preserved.

In fireworks and war.—The Greek fire of the ancients is supposed to have been largely naphtha or crude petroleum with niter and sulphur. During the Commune in Paris in 1872, petroleum was largely used, both offensively and for defense. Its uses as an agent in war will probably be increased, as it becomes more abundant and attainable.

As a *lubricator*, the heavy mineral oils are extensively used.

ASPHALTUM—THE USES MADE OF IT IN EARLY TIMES.

Asphaltum was first found on the shores of the Dead Sea, which, for this reason, was called Lake Asphaltus. It was employed by the ancients for various purposes, having been used in the construction of buildings and the walls of cities, and by the Egyptians in embalming the dead. It is recorded that Noah covered the inner and the outer surfaces of the ark with pitch—bitumen, or asphaltum, no doubt. Herodotus relates that in laying up the bricks of which Babylon was built, hot asphaltum was used as a cement. The material was brought from the city of Is, located on a small river of the same name, a tributary of the Euphrates. This river, it is stated, brings down lumps of asphaltum floating on the water, this being the source whence the builders of Babylon obtained their supply. Strabo, Book XVI, Chapter 2–42, in speaking of Lake Sirbonis (the Dead Sea), says that asphaltus rises to the surface in bubbles, which emit an insensible, sooty vapor, that tarnishes silver, copper, and even gold. This substance is liquified by heat, but on cooling becomes so hard that considerable force is required to break it to pieces. In gathering it, parties go out on the water on rafts. In another place, the same author remarks that this material is abundant in Babylonia. Eratosthenes, speaking on the same subject, says the liquid asphaltus, called naphtha, is found in Susiana, and the dry kind, which can be made solid, in Babylonia, the latter being of great utility in building. Diodorus also makes mention of the Asphaltus Lake, on the surface of which he says the asphaltum rises at certain seasons of the year in masses, some of which cover an area as much as three acres in extent. In gathering it, the workmen went out on rafts built of reeds; just as the California Indians were in the habit of crossing rivers on similar structures made of tules.

Not in many countries, comparatively speaking, has asphaltum been found in large quantity, California being one of the few, and the only portion of the United States, in which it so occurs. Among foreign localities, a very remarkable deposit of this mineral exists in the Island of Trinidad, one of the British West Indies, and which is described as follows by U. S. Consul Towler, who recently visited it: To call this deposit a lake, as is usually done, is, according to the above authority, a misnomer, as it consists merely of a concrete, slightly flexible mass of pitch, spread out over a plain, some portions of it being covered with bushes and others with pools of water, and over which, but for these obstructions, a person can walk without difficulty. The deposit is distant one and a half miles from the seashore, above which it is elevated about 140 feet. The asphaltum is broken out with picks and carted to the port of La Bréa, where it is shipped to foreign countries. Only a foot or two of the surface is removed, the pitch below this becoming soft and plastic. The excavations made fill again in a short time with the fluid material from below, the new deposits hardening very soon into asphaltum. How long this reproducing process can be continued is uncertain, though it will no doubt, with lapse of time, grow more feeble, and, perhaps, ultimately be arrested altogether. Nevertheless, the visible supply here is large and will last a long time, the surface to a depth of one foot being estimated to contain 116,678 tons of asphaltum.

There exist several heavy deposits of asphaltum in California, this mineral, both natural and manufactured, being well represented in the State Museum. The earliest official mention of its existence is made by Dr. J. B. Trask, who, in his report of 1854, folio 59, speaking of the occurrence of asphaltum and mineral oil in the State, suggests their use in the manufacture of gas.

An analysis made of a sample of this mineral (5608), from the claim of Mr. A. Walrath, located near Santa Cruz, resulted as follows:

Asphalt	19.80
Sand	80.20
	100.00

Another sample, obtained from Santa Barbara County, gave:

Bitumen, volatile portion	35.0
Bitumen, fixed	7.2
Quartz sand	57.8
	100.0

The sand is angular, and consists nearly all of transparent quartz. The bitumen is soluble in turpentine. The above results denote very nearly the general character of California asphaltum.

WHERE FOUND IN CALIFORNIA.

The following comprise the more notable localities of asphaltum and maltha in this State: Santa Ynez and Kayamos Valleys; near Mission San Buenaventura; at the Goleta Landing, seven miles west from the town of Santa Barbara; on the Laguna Todos Santos and Los Alamos ranchos; in the vicinity of Dos Pueblos, and near Carpenteria, in Santa Barbara County; at the oil wells near Sulphur Mountain, Ventura County; Rancho La Bréa, Los Angeles County; on the Corral de Piedra, San Luis Obispo County; about Buena Vista Lake, Kern County, and on Sargent's ranch, Santa Clara County.

THE CARPENTERIA BED,

Situated three miles southeast of the town, though not spread over so large an area as some others, shows the heaviest surface accumulation of any deposit in the State. This bed, already large, is constantly being added to, the more volatile portions of the maltha and petroleum, which issue from innumerable fissures in the mass, escaping and leaving the heavier behind. This residuum hardens gradually, at first to the consistence of tar or putty, becoming finally so solid that picks and crowbars are required for breaking it out. The softer portions of this material, flowing off and gathering up the sand and gravel with which they come in contact, have been converted into a vast bed of concrete, some parts of which extend far out into the sea. The mineral oil at this locality exists under such varying conditions of fluidity and hardness, that it is possible to obtain here some pure petroleum, together with large quantities of asphaltum and maltha. Formerly a good deal of asphaltum was shipped from this deposit to San Francisco.

LA BREA RANCHO,

So named from the Spanish word "*bréa*," signifying pitch, lies about six miles west from the city of Los Angeles, being in Township 1 south, Range 14 west, San Bernardino meridian. The deposits here, which cover a large area, consist mainly of bitumen and maltha, the latter occurring in the form of pools or wells. As at Carpenteria, the tar-like substance here flowing from numerous apertures becomes mixed up with such quantities of matter, both mineral and vegetable, that the whole mass has to be melted and the impurities separated from the asphalt to fit the latter for market. To effect this, the material is thrown into iron kettles and enough heat appplied to melt it, when the impurities floating on the surface are skimmed off, additional material being thrown in till the kettle is nearly filled with comparatively pure asphaltum, when the charge is poured out into trenches dug in the earth. On cooling, these pigs are broken up into smaller pieces, producing a commercial article of asphaltum. From this locality the Catholic fathers obtained asphaltum for roofing the missions and other buildings put up at Los Angeles, San Gabriel, and elsewhere in the vicinity.

AT SULPHUR MOUNTAIN

The solid asphaltum covers many acres to a depth varying from five to twenty feet. This bed, like that at Carpenteria, is undergoing constant enlargement, this process of growth being, in fact, characteristic of this class of mineral deposits in California, as it is probably of those in all other countries where they occur. Here, too, the petroleum, much of it quite pure, oozes from the fissures and vents seen all over the field. Flowing off, this more liquid portion becomes gradually thicker and thicker, until it is at last converted into tar, owing to the presence of which the locality has been rendered dangerous to animals, both wild and domestic, many of which, having become mired, have perished in the viscid mass. Even birds, alighting upon and getting their feet entangled in this stuff, have been unable to extricate themselves, as their bones and other remains amply attest. This tarry outflow, with its danger to animals, is another feature common to these *bréa* beds of California. The owners of stock in the neighborhood of these tar pools are in the habit of burning them out, as a means of diminishing the peril to which their cattle would otherwise be exposed. It only needs to start a fire, when the flames, sweeping over these pools, consume the more fluid portion of their contents, leaving a comparatively solid mass behind. As is the case generally throughout the oil regions of this State, the geological formation here consists of clay shales, alternating with sandstone, and is highly inclined.

ON SARGENT'S RANCH.

This place is situated a few miles south of the town of Gilroy, in Santa Clara County. The deposits here are located on Tar Creek, along which they extend at intervals for a considerable distance. They occur in much the same manner as those already described, the petroleum oozing from the sandstone and flowing off, becoming inspissated into maltha and asphaltum, large quantities of which have accumulated at different points along the creek. At the first considerable deposits met with going up the creek works have been put up for purifying the bréa by fusion and straining, the apparatus and process employed not differing much from those in use at La Bréa, Los Angeles County. The liquid asphaltum here exudes from the hillside in a thin tarry stream, which has so little motion that it is scarcely perceptible when the weather is cool, but which increases with the temperature of the atmosphere, and, spreading out, it becomes mixed with the black loam that here composes the surface soil, rendering this portion of the material very impure. Much of the asphalt at this place presents a vitreous appearance, like the best quality from Trinidad. Some of the pools formed here are as much as ten feet in diameter, and of unknown depth. In cool weather it is possible to walk over almost every part of these beds, but on warm days, the surface being slightly softened, this is impracticable. When dug up and thrown into heaps, the hard asphaltum, at ordinary temperatures of the atmosphere, gradually softens and spreads out into a thin sheet. Experimenting with a large slab of hard asphaltum in the State Museum, it was placed on four corks, and left so supported for a short time, when the lump sank to the table, imbedding the corks wholly in it.

In digging anywhere beneath the deposits on the Sargent Ranch the earth is found to be permeated with asphaltum, which can be recovered by the usual method of heating in kettles. Even in the bed of the creek masses of the mineral are met with, much of it so hard as to be quite brittle. Mixed with this asphalt are found samples of a mineral resembling ionite. From the lower plateau, where the purifying works are located, some twenty or thirty tons of asphaltum have, one time and another, been taken.

Half a mile further up Tar Creek, other large beds of asphaltum are encountered, having their origin in a line of springs located on the bank of the stream, and about thirty feet above its bed. A few rods above these deposits, many bowlders containing fossils were observed, and some of which were secured, mention thereof being made elsewhere. There is noticeable here a conglomerate and a sandstone cropping, the latter so friable that it can be crushed between the fingers, but neither appear to contain any fossils. From these deposits, seventy-five carloads of asphaltum have been sent to San Francisco.

Proceeding one and one half miles further up the creek, a third and much the largest bed of asphaltum in this series is met with, the deposits at this place covering several acres. The land here, as at the points below, spreads out into a sort of plateau. On the sidehill, above the deposits, are located the supplying springs, many in number. The oil here flows out in sluggish streams, portions of it mixing with the black soil, rendering it very impure, and the whole condensing, first into maltha, hardens at last into asphaltum. In some places, large tarry pools have been formed, in others little mounds of bréa, resembling the tufa deposits of mineral springs. From the surface of these pools, gas escapes in bubbles similar to those observed at the Mud Lakes on the Colorado desert. Here, too, are to be seen the remains of birds and small animals that, getting entangled, have perished in the treacherous tar. From this locality two hundred carloads of asphaltum have been shipped to market. About twenty years ago, a refinery was put up on Sargent's Ranch, at which a good illuminating and a very superior lubricating oil were produced in considerable quantity from petroleum gathered along Tar Creek.

ARAGOTITE.

This mineral, a hydro-carbon, was found by F. E. Durand, in the New Almaden quicksilver mine, and, so far as known, is peculiar to the quicksilver mines of this State. This new mineral, which is of a pure yellow color, was described by Mr. Durand, in a paper read by him before the California Academy of Natural Sciences, April 1, 1882, and possesses the following properties: In a glass closed tube it sublimes and gives off a voluminous sublimate of fine golden yellow needle crystals. Heated quickly it carbonizes and gives residue of carbon, with empyreumatic odor, not attacked by acid. Found in the New Almaden quicksilver mine, Santa Clara County, in dolomite, and with cinnabar in the Redington quicksilver mine, Lake County, and in the California quicksilver mine, Yolo County, all in this State. A sample of this mineral from the California mine, in Yolo County, is represented in the State Museum by No. 338, but it is too small for analysis. "Idriatite," a similar mineral, is found in the quicksilver mines of Idria, Austria.

PRICES, USES, AND CONSUMPTION OF ASPHALTUM.

While we do not employ asphaltum in laying up the walls of either houses or cities, as did the ancients, it is still used at the present day for many purposes—in California, as elsewhere throughout the world, mainly for the construction of street pavements, sidewalks, roofing, cellar floors, for coating water pipes, etc. The quantity consumed in this State amounts to about three thousand five hundred tons per year, the annual receipts at San Francisco reaching two thousand five hundred tons, the most of it coming from Santa Barbara County. About five hundred tons of the above amount are obtained from Corral de Piedra, and smaller quantities from various other deposits in the State. At one time the supply for nearly the whole State was procured from the Carpenteria bed; latterly, however, but little has been shipped from that locality. The Santa Barbara product being preferred by consumers, commands from twenty to thirty per cent more than any other offered on the market. The present wholesale price of asphaltum in San Francisco is $13 per ton for the best, $9 to $11 for a poorer article. The above are somewhat below the usual rates, which in times past have generally ranged from $12 to $16 per ton, having occasionally been as high as $30. The cost of extraction varies from $2 to $3 per ton, according to the hardness of the material, which is sometimes so solid that it has to be blasted out with powder.

SIDEWALKS AND PAVEMENTS.

Although asphaltum for sidewalks is being constantly superseded in San Francisco by artificial stone, its consumption is steadily on the increase, owing to the many new uses to which it is being applied. In many of the large cities of Europe this mineral appears to be growing in favor, not only for sidewalks, but also for street pavements, this being especially the case in London, Paris, and Berlin. In the latter, large sections of old pavements were not long since taken up, and a pavement composed chiefly of asphaltum put down in their place. Asphaltum pavements laid by a San Francisco firm on some of the greatest thoroughfares of London are said to have given entire satisfaction. After many and long trials made with wood, cobbles, granite, basalt, and macadamizing with gravel and jasper, the citizens of San Francisco are looking for a pavement that will last moderately well and yet be free from the objections that lie against the use of the above materials for paving their streets.

The following is the formula generally employed in preparing the material used in the construction of asphaltum sidewalks and pavements in San Francisco: 500 pounds asphaltum, 1 ton gravel, 15 gallons coal tar.

The asphaltum having been melted in a large vat, the gravel and coal tar are added, after which the mixture is ladled out and poured over a layer of soft bricks, or a flooring of redwood boards cut into short sections, and set on end in a bed of sand. As soon as the mass is poured out, it is leveled down and smoothed by passing over it hot flat irons with long wooden handles. In some instances, coarse gravel or small fragments of quartz are introduced into the mixture before being laid on the sidewalk, these being intended to receive the principal wear, and thus preserve the asphaltum.

Robert Skinner, of San Francisco, has invented a process for manufacturing an asphalt pavement-block by compression, and which is briefly described as follows: Calcareous material after being crushed is heated and brought in contact with hot asphaltum. This material is then forced into molds under a pressure of not less than 50 tons, after which, having been cooled in water, it becomes homogeneous. A block manufactured by this method (3606), can be seen in the State Museum.

FOUNDATIONS FOR MACHINERY.

A concrete has lately been used in Europe for constructing the foundations for heavy machinery, for which it has been found to answer an excellent purpose. This style of foundation is prepared in the following manner: A box of the proper size having been made, a layer of hot gritted asphalt is poured in and covered with a stratum of perfectly dry bluestone and rubble; then another layer of the hot asphalt followed by a layer of the bluestone and rubble, till the structure is brought to the required height.

ASPHALTUM WATER PIPES.

In 1870–71, asphaltum pipe was manufactured by J. L. Murphy, at his works on King Street, San Francisco, by coiling burlap, after being passed through a trough filled with melted asphaltum, on a wooden mandrel covered with paper to facilitate its removal. Any desired thickness and strength could be given to the pipe by regulating the length of the cloth in proportion to the size of the pipe required. When used for the water supply of towns, it was made to resist an internal pressure of 500 pounds to the square inch. When taken off the mandrel the pipes were glazed inside, by stopping up one end, pouring in some melted asphaltum and then rolling them rapidly on a table, the superfluous material flowing out at the open end. The table was covered with coke dust, a portion of which adhered to the outside of the pipe, forming a smooth, dry, and hard coating. This pipe was light, durable, and cheap, costing, inclusive of couplings, a sum per foot equal the diameter of the pipe multiplied by ten cents. Thus, two-inch pipe costs twenty cents per foot; four-inch pipe, forty cents per foot, etc.

NOTES.

The following article, on the uses, properties, and different qualities of asphaltum, and the best methods of preparing it, is here given for the reason that it embodies the views of a well known resident of San Francisco, who has had much practical experience on this subject:

ASPHALTUM.

This is one of the most abundant and valuable native products of California. Except in a very few instances, its properties and uses are but imperfectly understood and insufficiently appreciated. When used at all, it is commonly prepared so badly that when applied it soon decays, and fails to answer the purpose intended; whereas, if properly prepared, it is one of the most enduring of substances. I have seen places on the coast, in Santa Barbara County, where the liquid asphaltum, or "maltha," oozing from the banks, has attached itself to the rocks between high and low tide, exposed to the sun, wind, and waves; sometimes dry, sometimes wet; subjecting it to the severest test imaginable; and yet the rock was worn away about it, while the spots covered with asphaltum were perfectly sound and smooth.

In this city, when asphaltum is used for roofing, sidewalks, etc., it is usually prepared very badly, and so as to nearly destroy its best properties. For instance, it is boiled and stirred till most of its virtue is expelled, and it becomes nearly as dry and crumbly as coke; then something is poured in to soften it again—"to temper it," as they say—this something being *coal tar*, which vitiates the asphaltum, poisons it, and destroys all its virtue. Coal tar has no chemical affinity for this mineral, no property in common with it. They are, in fact, about as incongruous as two substances well can be. They will mix mechanically while hot, but they will not stay mixed. The coal tar evaporates in the sun and air, and washes away in the rain, leaving the asphaltum not solid, but honeycombed and porous, disintegrated and crumbly. The coal tar seems to have destroyed the native tenacity of the asphaltum, which soon perishes after this stuff has been eliminated from it.

Let any one interested in this subject observe, as he passes along our streets, after a heavy rain, and he will see, where the streets or sidewalks are laid in asphaltum, little pools of water with an iridescent surface; these colors come from the coal tar, washed by the rains from the mixture of that substance in the asphaltum sidewalks. A little further attention will reveal the fact that this piece of coal-tar-asphaltum sidewalk, which looked so smooth and pretty when first laid, is already growing rough on the surface, the gravel in it becoming loose, as the fabric begins to decay.

The best asphaltum is that which is pure and soft, and most free from sand, dirt, and dry, hard stuff, like coke. It is sometimes found as pure as if it had been carefully refined, as clear and bright as a black glass. The specimens from our California mines are more or less mixed with coarser substances. Sometimes the mass of it appears dry and coke like, as if it had already been cooked too much. This sort sometimes has veins of the stuff running through it, still plastic and fresh; this is the best part of it, and good so far as that goes. When it is dry and crumbly, be sure that the best of it has by some means been wasted.

HOW TO PREPARE IT.

To prepare asphaltum properly for pavements, for instance, it should be cooked for some hours over a slow fire, stirring it the while. Probably superheated steam, or a steam jacket, next the boiler, would be effective, without the danger of burning it, as when the fire comes in direct contact with the vessel containing the mineral.

After cooking gently for awhile, mix with it the residuum of petroleum, from which kerosene has been made. This substance is homogeneous with asphaltum, and the product of the mixture, properly cooked, is a most tenacious substance, which will draw out to a thread, almost imperishable. Its proper temper may be tested by dropping a little of the hot stuff from the kettle into cold water. If it will then pull out like warm taffy into a string, it is in perfect condition for use.

Such a compound, well mixed, while hot, with finely crushed rock, dried and heated, and thoroughly tamped or rolled while the mass is still hot, makes a good sidewalk and pavement; smooth, and capable of enduring a great amount of wear with the least apparent waste, decay, or signs of abrasion.

A specimen of such pavement may be seen in front of the engine house of the California Street cable cars, corner of Larkin and California Streets, which, after about six years use, looks as sound as when first laid. Another piece of pavement, consisting of wooden blocks covered with a mixture of asphaltum and crushed rock, can be seen on Sacramento Street west of Montgomery. It has been there more than five years, and is still in perfect condition, no repairs having been required. It remains smooth, is noiseless, clean, and in the long run the cheapest of all pavements.

It would furnish the economist a useful field of inquiry to ascertain the relative cost and benefits of the ordinary cobble, granite, or basalt pavement with a pavement constructed of crushed rock and asphaltum. In a great populous growing city like San Francisco the *disadvantages* of a rough stone pavement consist in its being *noisy*, dirty, and in its *cruelty* to horses, which not only suffer more but are worn out twice as soon as where traveling on a smooth slightly yielding pavement. Then there is the loss of time, greater wear of vehicles, and increased discomforts to be considered, the whole aggregating a very important item in the account. A smooth pavement is just the reverse of all this, and when the advantages of such a pavement are considered we should find in a great city like this, after paying all the cost of construction and repairs, that there would be, at the end of every year, probably more than a million dollars to the credit of the smooth pavement, to say nothing of additional comfort, cleanliness, and quiet.

Asphaltum, well prepared, makes a durable coating for iron water pipes, inside and out, and when it comes to be better understood its uses will doubtless extend to a variety of things not now thought of. As it has served to protect the rocks on the beach of Santa Barbara, why would it not protect the granite stone work at Fort Point, which seems to be wearing away in the sea wash so rapidly?

From an extensive deposit of asphaltum located about eight miles from Santa Cruz, material has lately been taken for paving the streets of that town. The mineral, which in its natural state is here found mixed with sand, is heated until it becomes plastic, a little water having first been added. In this condition it is spread out over a stratum of broken rock, stamped down, and rolled while still hot. Thus far it has answered every expectation, and promises to prove a durable, as it certainly is a smooth, clean, and noiseless pavement.

The following is an analysis of a sample of maltha from the tar wells of Santa Barbara, made by J. M. Robertson:

Indorsed: Liquid mineral tar from Biggs' ranch, Carpenteria, Santa Barbara, Cal.

S. W. HOLLADAY,
302 Montgomery Street.

SAN FRANCISCO, July 1, 1884.

Nitrogen	2.25
Carbon	70.00
Hydrogen	10.00
Oxygen	8.50
Ash	9.00
Insoluble matter, whitish	.25
Centesimally	100.00

Wholly soluble in ether. Partly soluble in alcohol.

J. M. ROBERTSON, Chemist.

SAN FRANCISCO, August 20, 1875.

The following lists comprise the countries and localities in which petroleum has been found in greater or less quantities:

UNITED STATES.

Alabama, California, Colorado, Georgia, Kentucky, Maryland, New York, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia, West Virginia, Wyoming.

CALIFORNIA.

So far as surface indications go, petroleum has a wide range in California, springs and pools of the fluid being encountered in nearly all the coast and also in some of the inland counties of the State. In the more southerly tier of counties it generally occurs in connection with extensive beds of asphaltum or *bréa*, this being also the region of the more productive oil wells. To the extent above denoted petroleum has been found in the following counties in this State, viz.: Alameda, Colusa, Contra Costa, Humboldt, Kern, Lake, Los Angeles, Mendocino, Napa, San Bernardino, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Sonoma, Tulare, and Ventura.

FOREIGN COUNTRIES.

Argentine Republic, Burmah (Rangoon), Canada, Cuba, Germany, France, Italy, Mexico, New Zealand, Persia, Russia (Baku), Spain, Switzerland, Trinidad, United States of Colombia, and Venezuela.

HISTORY OF PETROLEUM IN CALIFORNIA.

Petroleum has been known to exist in California since the earliest settlement of the country. The black "maltha" oozing from the earth and standing in pools, or flowing from springs on the hillsides, was evidence of the fact; still no attempt was made toward utilizing this valuable material in a large way until 1857. About this date, as near as I can gather, Mr. Charles Morrell, a druggist in San Francisco, made the first attempt to produce coal oil from California crude materials. He commenced operations in Santa Barbara County, near the line of Ventura County, in the vicinity of Carpenteria. The bluff on the seashore is about fifty feet above tide level, and from eight to ten feet below the surface there occurs a stratum of coarse sand, of a yellow color, two feet thick and lying horizontally, or nearly so, that is saturated with maltha, mineral tar, or liquid asphaltum. Mr. Morrell erected quite extensive works, well supplied with cast-iron retorts, furnaces, etc., in which the crude material was refined by distillation, and oil produced; but for some reason not now known, the enterprise was a failure.

In 1856 a San Francisco company commenced working at the Brea ranch, near Los Angeles, and tried to obtain refined oil; the particulars of their operations are not now obtainable.

Andreas Pico knew the locality now called Pico Cañon, Los Angeles County, for some years before Mr. Morrell established his refinery, and had made oil for the San Fernando Mission in a small way, in a copper still and worm. He was probably the pioneer coal oil manufacturer of the State.

In 1857, W. W. Jenkins, W. C. Wiley, and Sanford Lyon, visited Pico Cañon to look for mineral and oil. Francisco Lopez, former steward of the San Buenaventura Mission, and superintendent of the gold placers, had informed them that there was oil, which they found oozing from the ground in what are now called Pico, Hooper, Sespe, Casteca or Pine, and Piru Cañons. No further attempts to produce coal oil appear to have been made until 1864; when the Buena Vista Petroleum Company was incorporated, in February, but active operations were not begun by them until the following year, when they commenced work in Tulare County under the title of the Buena Vista and the First National Petroleum Companies.

April 8, 1865, Professor Silliman published a letter to the Hon. D. H. Harris, entitled, "California Oil not Asphaltum." This letter was afterwards printed in the *Mining and Scientific Press.* Silliman quoted Professor Brewer, to the effect that the oil at Humboldt was light enough to burn quite well in a chimney lamp without refining. Also, that one spring on Azuza (now Sespe) Mountain, behind San Buenaventura, furnished an oil so thin that Brewer had seen it in use in a common lamp without rectification. Professor Silliman wrote that he had obtained ninety-six per cent of good oil from a sample of it. The publication of this letter had great influence in stimulating the search for and study of California oils. None of the wells had at this time reached any considerable depth, but there was great activity in prospecting for oil.

About this time, J. C. Cherry came to California, having in contemplation the erection of an oil refinery. He visited and made a favorable report on the property of the Point Arenas Oil Company.

The San Fernando Petroleum and Mining District was located in June, 1865, with Mr. C. Leaming, Recorder, who still holds that office, and the San Fernando Petroleum and Mining Company incorporated.

During 1865 operations were commenced on Mattole Creek, Humboldt County, by the North Fork Oil Company, and on August third, at the Mattole well, a burst of oil and gas rose several feet above the opening. This action lasted for a few minutes only, but left the well full of oil. The next day it was pumped out, and the same action was repeated, as was the case on the fifth and sixth days. Thirty barrels of oil were shipped to San Francisco. "Six twenty-gallon casks of crude oil," by another statement, was the first shipment of oil received from the north.

The Bolinas Petroleum Company began operations at Bolinas Bay. The works were situated in the Arroyo Honda, on the Bolinas grant.

The San Pablo Petroleum Company, located one mile from San Pablo, Contra Costa County.

At the Adams well, Mount Diablo, San Joaquin County, active operations were commenced. The Adams was the pioneer in that district.

Near Lexington, Santa Clara County, some Portuguese sunk an open shaft 135 feet deep; no results were obtained beyond indications; the prospect was for coal.

In Moody Gulch, Santa Clara County, the McLeran(?) well was sunk to a depth of 500 feet, and about one barrel of oil obtained per day. Moody Gulch was named from Moody's sawmill that once stood there.

Oil was discovered on Bell's ranch, 15 miles below Halfmoon Bay, San Mateo County, and at Purissima Creek.

The Pennsylvania Petroleum Company commenced operations near the seacoast, six miles south of Santa Cruz.

The Philadelphia and California Petroleum and Santa Barbara and California Petroleum Companies were incorporated.

Rowe and Fleeson sunk a well one mile below Simmons Spring, Sulphur Creek, Colusa County.

The Antelope Valley and the Pioneer Oil Company, Colusa County, commenced operations for the second time. .

The Los Angeles Petroleum Oil Company began sinking a well by steam power, and on April twenty-eighth were down 130 feet.

The Paragon Petroleum Company commenced operations, and the Humboldt Oil Company was incorporated.

In May forty cases of crude oil were sent to San Francisco from the San Joaquin and Pacific Oil Companies of Tulare County, which was shipped east on the steamer of the eighteenth.

In this year there was published a tabular statement, naming the oil companies to the number of sixty-five. Nominal capital, $45,-000,000.

In 1866 Mr. Charles Stott began work on Santa Paula Creek, Ventura County, at the base of Sulphur Mountain, and erected a refinery on a small scale. He made several thousand gallons of illuminating oil, and then gave up the enterprise because it did not pay. October twenty-second, the San Francisco *Alta* published an article on petroleum and refineries, giving Charles Stott credit for refining the first oil in this State.

In this year there were two refineries established in San Francisco, one owned by Hayward & Coleman, the other by Stanford Bros. Neither of these establishments achieved any considerable success, and were eventually abandoned.

Mr. —— Polhemus, also, had a refinery at Los Angeles. A portion of the crude oil which he refined was obtained from wells near the town of Los Angeles, and some was hauled by teams from Pico Cañon.

Mr. Hughes bored for oil in Pico Cañon, and struck a flowing well at 140 feet, but the tools became fast in the well and could not be extricated.

A well was sunk on the Potrero, in San Francisco, but the result was not satisfactory. There was considerable excitement about oil during this year.

The "Pioneer Petroleum and Refining Company," of San Francisco, was incorporated. Charles Stott, David Hunter, and H. P. Wakelee, Trustees.

In 1867 Lyon and Jenkins returned to the claims they had examined ten years before. Jenkins went to Sespe and Piru; Lyon remained at Pico. Lyon's Station was named from him; he died in 1883.

The "Fargo" well, sunk at Moody Gulch to a depth of 400 feet, yielded one barrel per day; and from a well at Griswold's place, two miles from Lexington, 500 feet deep, some oil and salt water were obtained.

In a well sunk in Colusa County the water in the well was seen to rise like a tide at 3 P. M. and at 6 A. M. At Antelope Valley, 18 miles north of Oil Center, in the same county, there is a salt pond, and salt water is found in the oil wells. At this time eight oil wells had been sunk in Colusa County.

On January twenty-eighth, twelve barrels of crude oil were shipped from Pico Cañon, Los Angeles County.

The following account of the operations of the Buena Vista Petroleum Company—whose oil claims, comprising some twelve to sixteen hundred acres, are situated in Kern County, west side of Tulare Valley—is of interest. The exact location is Township 30 south, Range 22 east, Sections 19, 20, and 29, and in Township 30 south, Range 21 east, Sections 12 and 13. Previous to 1866, Mr. Stephen Bond and Mr. E. Benoist commenced a well on the flat below the tar springs on the company's claims. At a depth of sixteen to eighteen feet, in raising the auger they turned it the wrong way and unscrewed and lost the bit, which accident stopped the work.

In 1866 the Buena Vista Company set a still with a daily capacity of 300 gallons near a large spring of good water, three miles from the oil springs. The company attempted to sink a well for water in a more convenient location but did not succeed in obtaining it. For thirty feet or more the formation was alternate layers of shale, sand, and asphaltum; below thirty feet was a three-foot stratum of asphaltum very difficult to penetrate, but no water. Two adobe buildings were erected, one for the refinery, the other for the workmen. The oil belt lies along a low range of hills for several miles north and south, on which sulphur springs are quite numerous. Most of the oil croppings are from 200 to 500 feet above the level of the valley. At the Buena Vista springs the oil has flowed out and covered several acres in the form of glossy black asphaltum. There are numerous bubbling tar springs on the flat, from which liquid asphalt or oil flows and gases emanate. Sometimes the imprisoned gases form a globular bubble in the thick oil a foot or more in diameter, which eventually bursts and the tarry liquid subsides again to its level. The asphalt stream extends half a mile or more over the sandstone and to the valley below. The crude oil for the refinery was taken from pits or shafts sunk from 16 to 18 feet deep. There were also several shallow pits or wells which soon filled with oil and water. At the bottom of the shafts a quicksand of oil, water, and sand was met with which could not be overcome by curbing, or otherwise controlled. An open cut was then made into the hill, but a solid formation of sandstone and thick beds of asphaltum were met with. The cut was 7 to 8 feet deep and 4 wide, from which some tarry asphaltum was obtained and distilled. At one time, from the shafts and cut, it was believed that from 5 to 8 barrels a day could be collected. Oil procured from the surface marked 10 to 12 degrees Beaumé, at a depth of 10 feet in the shafts it marked 12 to 14 degrees, and at 20 to 30 feet in depth an oil was found as light as 21 degrees.

Three thousand to four thousand gallons of refined oil were produced. In the distillation the following results were obtained: First run five to seven per cent from forty-seven to forty-three degrees, forty per cent from forty to thirty degrees, thirty-five to forty per cent from twenty to sixteen degrees. The residue left in the still was soft asphaltum, which could be removed without difficulty. They generally ran off from eighty-five to ninety per cent from the charged still, when the residue would continue to run off from the tap while hot. Many difficulties met with by the company caused the work to be abandoned. Freight was high, $60 to $70 per ton to San Luis Obispo, and from $15 to $20 more to San Francisco. The nearest fuel or timber were the forests of the Santa Meta Mountains, lying thirty miles south. From the time the company discontinued work nothing has been done at this locality. Many bones of animals, thought to be fossil, were found in the vicinity. In this year Professor Silliman wrote his celebrated paper on California petroleum, which has called forth so much comment. It was published in *Silliman's Journal*, previous to its being read before the California Academy of Sciences, April 1, 1867, for which reason it was not published in the proceedings of that society. The following are extracts from a condensation of the paper, which appeared in the *Mining and Scientific Press*, April 6, 1867. The experiments were made on a sample of oil from Mattole Creek, Humboldt County, a thick viscid maltha, having a density of .980=31° B. By fractional distillation he obtained a series of light and heavy oils, ranging from .700 to .918 specific gravity. No paraffine was obtained by freezing with a mixture of ice and salt, from which he drew the conclusion that there was none of that substance in the California oils. The light oils obtained were 12.96, 14.56, and 18.96 per cent of the crude oil. It was his opinion that the oil of California could not compete with the oils of Pennsylvania at the prices then ruling, but he believed that our heavy oils would be extensively utilized as a fuel, in which prediction he has been sustained by history, has been shown.

Among the specimens from California, sent to the Paris Exposition of 1867, were petroleum from Mattole, Humboldt County; Joel's Flat, Noble Springs, Santa Barbara County; Wiley's Spring, San Fernando Mountain (Pico Cañon), Hughes' Spring, and Pico Spring, Los Angeles County; Hayward & Coleman's claim, Sulphur Mountain, Ventura County; Stanford Brothers' claim, same locality; from Canada Larga, Santa Barbara County; from Santa Cruz County; Bear Creek, Colusa County, and Charles Stott's claim, Santa Barbara County.

Experiments were made at Corral Hollow, San Joaquin County, to distil coal oil from shale, which did not prove a success.

In 1868 Mr. —— Davis leased the Wiley Springs in the San Fernando Mountain. He collected all the oil he could and sent it to the Metropolitan Gas Works in San Francisco for about a year. Metropolitan Gas Company's office was at that time at 810 Montgomery Street, San Francisco.

In 1869, the first work was done at Pico Cañon, by Mr. Hughes, who put down a spring-pole well called the Pico Well. A similar well was sunk about the same time at Wiley Springs. Wiley Cañon is three miles northeast from Pico Cañon.

In 1871, petroleum was discovered on the Augmentation Ranch, Soquel, Santa Cruz County. Oil was also found in Livermore Valley, Alameda County.

In 1872, Charles Stott again worked the Sulphur Mountain property in Ventura County; this time with better success.

In 1873, the Star Oil Company, of Los Angeles, built their first still in San Francisco, and shipped it to Los Angeles County. The works were established at Lyons Station, under the superintendence of Captain William B. Smith, refiner. This was one mile from the present Newhall Station, and was the foundation of the present refinery at Pico. Wood was used as fuel. There were many different ideas as to the nature of the oil and the mode of purification. No satisfactory results were obtained at this time, and in 1876 the works were sold to Scott & Baker, who also failed to make them pay. Mr. Shoemaker succeeded them, but did not produce oil in sufficient quantity to be profitable. Mr. J. A. Scott then took the refinery, and met with fair success.

In 1874 Messrs. Temple, Moore, and Pico, worked in Pico Cañon. The oil they obtained was sent to the refinery at Lyons Station, which was subsequently removed to Pico. At this time there was considerable activity in the production of petroleum at Sulphur Mountain, Ventura County, so named from the numerous sulphur springs. Hayward's claim produced ten barrels daily of 32 gravity oil. Stanford's, six barrels daily; Santa Paula Oil Company, ten barrels daily; San Fernando Company, near Canulos, about ten barrels daily. All the oil was obtained from natural flows. Two hundred barrels per month was used by the Central Pacific Railroad for lubricating purposes, but beyond this there was no demand for the crude material. At this time there were also some new oil springs discovered at Sespe.

During the year 1876 the Star Oil Company was engaged in sinking wells in Pico Cañon. The yield of the district amounted to forty barrels per day.

In 1877, the California Star Oil Company, of Los Angeles County, under the management of J. A. Scott, produced twenty barrels of refined oil daily at the Pico refinery. The Ventura wells were then producing eighty barrels daily, and those of Pico Cañon from forty to fifty barrels. Work of development by steam machinery commenced at this locality.

In 1878, Chas. N. Felton and P. C. McPherson commenced work in Moody Gulch on the old Boyer well. At 700 feet a rush of oil and gas occurred which rose 100 feet above the mouth of the well and 100 barrels of oil were supposed to have been lost. For some time after 60 barrels of oil per day were pumped from this well, which had a gravity of from 46 to 47 degrees Beaumé. The oil was sent to the Pico refinery, near Newhall, Los Angeles County. In September of this year, in a communication to the *Mining and Scientific Press*, Mr. Edward Madden, an oil expert, stated that the oil of Ventura County was inferior to that of Pennsylvania as an illuminator, but superior as a lubricator.

In the same paper he gives the production of the Star Oil Works at 150 barrels per day, and the yearly consumption of California at 3,500,000 gallons, valued at $1,000,000. His opinion, based on surface indications, was that the southern portion of Los Angeles County was full of oil.

October, 1879, the *San José Mercury* contained an account of the successful prospecting for oil in Moody Gulch, Santa Clara County, Santa Cruz Mountains. Dall Brothers, employed by the Santa Clara Petroleum Company, at a depth of 600 feet struck a vein of oil which spouted 100 feet above the top of the well. Having no tanks, etc., 100 barrels or more of oil ran to waste. After a time the flow subsided but recurred again at intervals. This strike created a great excitement.

At this time, there were five wells at Pico from 200 to 600 feet deep; eight wells in Ventura County on ex-mission lands, from 100 to 200 feet deep, all yielding oil by pumping, in all, 20 barrels per day; and one well at Sespe 1,500 feet deep, yielding 100 barrels per day. September tenth, Pacific Coast Oil Company of San Francisco was incorporated.

In 1881, A. C. Dietz & Company established the Berkeley Lubricating Oil Works, for the manufacture of lubricating oils from California material brought from Ventura County. They turned out 100 barrels per day. In February, there were seven new wells being drilled in the State, and the product during the past year had doubled. The oil business in California was at this time of greater magnitude than was generally supposed. Citizens of Los Angeles, Ventura, and Santa Barbara Counties, signed a petition asking the U. S. Government to instruct Clarence King, Geologist, to make surveys of the oil districts; and to note the progress of development since 1865. They represented that a belt of oil shale extended for eighty miles in length, from the San Fernando district in Los Angeles, through the Sespe, Santa Paula, Ojai, and Sulphur mountains in Ventura County, and the Carpenteria and Santa Barbara districts, terminating in the Pacific Ocean at Goleta, in Santa Barbara County. That, although the indications were encouraging, yet the work had been done somewhat blindly, and without scientific guidance; much money had for this reason been lost, believed to be as much as $1,000,000 with unsatisfactory results. Practical oil men, and capitalists, familiar with the subject, were of the opinion that the results of their work indicate that large quantities of petroleum of good quality exist, but that they fear to progress without scientific guidance. In consideration of the importance to the whole country of the vast interests involved, they felt they had a right to ask aid from the General Government.

This year (1884), Mr. Lyman Stewart, of the firm of Harrison & Stewart, informed the State Mineralogist that the Pennsylvania company of which he is a member has invested, in Pico Cañon and elsewhere in Los Angeles and other counties, $130,000, a large portion of which is a loss. They sunk six wells in Pico Cañon and one at Santa Paula, all of which are "dry holes." Mr. Stewart is from Titusville, Pennsylvania. He brought out thirty men, all skilled workmen. Some of the wells sunk by them were very deep. He said that if he could obtain oil in one well, the company would soon make up the loss. They are now boring in Pico Cañon, near the Pico well.

PETROLEUM IN CALIFORNIA—LOS ANGELES COUNTY.

The Chandler Oil Mining Company, of Los Angeles, was incorporated February, 1884, George Chaffey, President, C. H. Howland, Secretary, B. Chandler, Superintendent. The company's wells are at Petrolia, Section 5, Township 3 south, Range 9 west. They commenced operations on Puente Ranch, Section 1, Township 3 south, Range 10 west, and obtained oil at from 100 to 300 feet, sp. gr.=15° to

30° B. One well produced 150 barrels, which sells for $4 50 to $12 per barrel. Mr. Chandler informed me that within two years 5,000 barrels had been produced at Petrolia, which I visited in May, 1884. Two wells were being sunk: Number one was 290 feet deep; number two was 240 feet deep. From number one quite a quantity of "black tar oil" (maltha) had been pumped. A tank, holding from seven to ten barrels, was standing full. Common bréa, which contains what seems to be ionite, is burned under the steam boiler, and is the only fuel used. (The presence of ionite was also observed at Sargent, Santa Clara County.) The wells at Petrolia are on small foothill elevations above Anaheim, direction or trend of the hills is about east by south. A small creek runs down south by west to the plains. On both sides bréa has run down and formed terraces, as at Sargent, and the "black tar" is similar. Of the bréa there are several varieties: Cellular, like volcanic scoria, and mixed with sand; several grades pure "black tar," and some brown and light, like ionite, which it seems to be. At Swallow Point the soft sandstones resemble those at Pico Cañon. In several directions from the oil wells may be seen extensive patches of bréa, which have flowed from the hillsides.

Mr. J. W. Snow's well is about a mile from Petrolia. It is 550 feet deep, but unfortunately for the owner it is a "dry hole." There are large fields of bréa contiguous containing much of what is thought to be ionite. The sides of the cañon in which the well lies are sandstones and conglomerates, with rather thick seams of selenite interstratified. The stratification is confused and broken so that no section could be found exposed. A shark's tooth described elsewhere was found at this point.

The well was first a square shaft, 44 feet deep, from the bottom of which a six-inch well was sunk through soft sandstone. At 250 feet and for 150 feet lower probably, sandstone was cut through. The sand is like that in the bréa. High up the cañon sandrocks were found seemingly in place, dip 32°, strike N.W. to W.N.W. The tertiary fossils found here are described elsewhere.

SITES OF THE MORE PRODUCTIVE WELLS—PICO CAÑON.

At this place, seven miles southeast from the town of Newhall, Los Angeles County, the Pacific Coast Oil Company have sunk a number of wells, 16 of which are producing more or less oil, some of them yielding as much as 75 barrels per day. Besides the wells already producing several others are being put down. The borings here reach to various depths, many of the wells being down over 1,000 feet. Several have been sunk from twelve to sixteen hundred feet, and one has reached a depth of 1,900 feet. Many pumps and derricks can be seen here in constant operation, the former lifting the crude oil from the wells that are already yielding, and the latter working the boring apparatus of those being put down. The oil at this locality is found on one side of an anticlinal fold or break, as it is called, and after being pumped to the surface is collected from the various wells and conveyed by a four-inch iron pipe to the large receiving tank, located centrally to the group, whence it is carried by a two-inch pipe to the company's refinery, near Newhall. Some of these wells, after flowing sparingly for a time, again yield more freely, these periods of partial intermission occurring without much regularity.

The characteristic sandstone and conglomerates appear here, samples of which were obtained for the State Museum. Bréa deposits were also noticed on the adjacent hillside. In the vicinity of the wells are located the workmen's quarters, shops, and other outbuildings of the company; the manager of these works is Mr. R. Craig.

The oil wells, refineries, and plant of the Pacific Coast Oil Company, of San Francisco, C. N. Felton, President, D. G. Scofield, Auditor, E. Wheaton, Secretary, are the most extensive and successful on the Pacific Coast. I addressed a letter to this company, asking certain questions, the answers to which I thought would be of interest to the people of the State. My questions, with the answers returned by the President of the company, are given below:

QUESTIONS.

Question 1. When was the Pacific Coast Oil Company incorporated?
Q. 2. When was work commenced in Pico Cañon, Los Angeles County?
Q. 3. What was the cost of the two refineries?
Q. 4. How much capital is invested?
Q. 5. Is the table of production in Williams' "Mineral Resources" correct (1878 to 1882 inclusive, 197,484 barrels)?
Q. 6. What has been the production since 1882?
Q. 7. How much was produced before 1878?
Q. 8. What is the daily average yield at Pico Cañon, Los Angeles County?
Q. 9. What has been produced in Moody Gulch, Santa Clara County?
Q. 10. To what extent has California oil decreased importation?
Q. 11. Is any California oil exported, and where?
Q. 12. What is the number of producing oil companies in the State?

ANSWERS.

Answer 1. September 10, 1879.
A. 2. Work was commenced in Pico Cañon in 1875, by the drilling of three shallow wells with spring pole, all of which yielded oil at depths of from ninety to two hundred and fifty feet. Actual work of development commenced with steam machinery in 1877.
A. 3. Refinery at Alameda Point cost $160,117 43; refinery at Newhall cost $25,266 64.
A. 4. Amount of capital invested, say, $2,500,000.
A. 5. Cannot say; have not seen table referred to.
A. 6. 190,540 barrels.
A. 7. See Journal of Commerce Annual for 1883.
A. 8. 560 barrels.
A. 9. About 24,000 barrels.
A. 10. About 33⅓ per cent of all kinds.
A. 11. Exported to British Columbia, Sandwich Islands, Mexico, and Society Islands.
A. 12. Companies actually producing oil: Pacific Coast Oil Company, San Francisco Petroleum Company, California Star Oil Works Company, Mission Transfer Company, Santa Clara Petroleum Company. Numerous companies have been formed, some have drilled shallow wells, but the above are all that have successfully produced oil.

TUNITAS CREEK, SAN MATEO COUNTY.

This oil district visited April 21, 1884, is situated in San Mateo County, being in Township 6 south, Range 5 west, Section 25. Several wells have been sunk here, one named the Balmoral, to a depth of 586 feet, without obtaining oil. From another, not named, light green oil was being pumped from a depth of 550 feet. The following phenomena, as furnished me by Mr. H. W. Bodwell, in charge of the work, were observed in sinking the Balmoral well:

From 100 feet to 140 feet showing of oil; best about 130 feet.
Two hundred and thirty-five feet, abundant salt water.
Two hundred and fifty-six feet to two hundred and eighty feet, showing of oil and gas.
Three hundred and eighty-six feet, smells strongly of gas.
Four hundred and thirty feet to bottom (586 feet), gas quite abundant.
Four hundred and sixty feet, black soot appeared on water very abundantly.
Four hundred and seventy feet, showing of oil.

Crude petroleum is used as a fuel under the boilers here, being applied in the usual manner with a jet of steam.

MOODY GULCH, SANTA CLARA COUNTY.

Visited this locality, which lies about two miles southeasterly from Alma, Santa Clara County, April 17, 1884. The deposits here are owned by the Santa Clara Petroleum Company, who have sunk two wells at the same level, but on opposite sides of the cañon, and about eighty-five feet apart, the elevation here being 970 feet above sea level. Each of these wells has been furnished with a hand windlass, steam engine, pump, etc. A tank, connected with the wells, has been put up here. From this tank a two-inch iron pipe extends to another and larger tank, located some distance down the cañon, and from which the oil is conveyed by a similar pipe, thence to the railroad, about one mile distant. These wells are named Moody Nos. 1 and 2, and though idle at the time of my visit, have produced considerable oil, judging from what could be seen and learned. The direction of the cañon changes at this point and continues towards the top of the hill, about W.N.W.

At a height of 1,040 feet another well, with derrick, engine, pump, etc., is encountered. But, as below, nothing here was being done, the machinery being partially dismantled and the whole place much neglected; though here, too, some oil had evidently been produced.

The next well, No. 7, was met with at an altitude of 1,120 feet. Here the engine was working and the water being bailed out, preparatory to further sinking. Though no oil in quantity had been produced here, I examined some brought up with the water, and found it to be thin and of a green color and good smell. There are signs of this well having at some time been on fire, though I was unable to learn much about its present condition or past history.

Ascending the cañon, the last well in this series was reached at a height of 1,160 feet, and about 200 feet below the summit of the hill. Here, some oil contained in a tank was examined and found to be fluid, and of good smell and color, quite unlike the tarry liquid seen at the Sargent Ranch. The power here is supplied by a steam engine of from eight to ten horse-power. From the main pulley, a belt extends to another near the mill. The pump is worked by a crank and beam, the machine being controlled by a friction pulley shifted by a lever. On the throttle of the engine there is fixed a small pulley, and a still smaller one near the pump where the fireman stands. A rope transfers the power from the larger to the smaller of these pulleys, enabling the fireman to shut off or turn on the steam at will, without moving from his station. The engine can also be reversed by the motion of a lever which changes the pitman from one eccentric to another. At the top of the derrick, standing over the well, there is placed a large iron pulley over which a rope passes, and running through a block near the floor extends to a winding pulley driven by the engine. There is also a heavier and shorter rope, and a hand-windlass, used in boring, drilling, etc. The oil is pumped first into local tanks, when it is carried by gravity to the collecting tank. Here the water having been drawn off, it is passed to the lower tank, and, finally, to the railroad.

REFINERIES.

The Pacific Coast Oil Company has erected works, for refining crude petroleum, at Pico, near the town of Newhall, Los Angeles County, and which were visited May 11, 1884, which is referred to in the "History of Petroleum in California." The offices of the company are located in the town of Newhall. The oil here treated is obtained from the wells in Pico Cañon, seven miles distant, whence it is conveyed through a two-inch iron pipe to a large iron tank or receiver. From this receiver it is again carried by gravity through iron pipes to the refinery. From the refinery the product and by-products are conducted to storage tanks. From these tanks pipes lead to the side-track of the railroad, these pipes being sufficiently elevated to discharge the oil into box cars, in each end of which there is a boiler iron tank of a capacity of 50 barrels—a carload consisting of 100 barrels of oil. The globe valves are reached from an elevated platform placed along the side-track. The stream of oil is guided into the manhole opening in the car tank by loose elbows and joints of pipe (practically a goose-neck). The manhole plates screw down. Elbows below are furnished with discharging cock, three inches in diameter, to which flexible tubes being attached the tanks are readily emptied of their contents.

Portions of the crude oil from this locality are sent to San Francisco, Los Angeles, Colton, Arizona, and elsewhere. It is used at Colton for burning lime, and at Los Angeles for fuel in electric light works and in burning brick. The refined oil is sold for local use in the southern portions of California and in Arizona. It is water white and burns freely in the mechanical lamp. Sp. gr. 797=46° B., which is rather heavy for a good burning fluid in the ordinary lamps. This Newhall refinery was erected before the extensive works at Alameda Point were put up. Though not protected by a building such is the mildness of the climate that no serious inconvenience has been experienced from this deficiency.

About four and a half years since, Mr. A. E. Edwards put up a refinery in the valley of the Santa Clara River, Ventura County, at which oil from the wells on the Little Sespe was treated. For the conveyance of the oil a pipe was laid down along the Little and the Big Sespe, connecting the wells with the refinery. The crude oil from these wells had a specific gravity of 42°. The refined was water white and burned well in lamps, according to an editorial statement in the Los Angeles *Commercial*. These wells lie in Section 6, Township 4 north, and Range 20 west, San Bernardino meridian.

May 5, 1884, I visited the refinery of the Pacific Coast Oil Works at Alameda Point, Woodstock Refinery, G. R. Miller, Superintendent. The works are contained in an area of 30 acres, in which there is ample room to increase the capacity of the works as occasion may require, which depends in a great measure on the supply of crude oil that can be obtained in the State.

The large retort now in use has a capacity of 850 barrels. The crude oil is forced in from the receiving tanks by steam pumps. The heat is generated under the still by burning jets of refuse petroleum, forced in by a jet of steam. The lighter oils first come over, and are conveyed through pipes laid in wooden boxes surrounded by water. The condenser is, in effect, a Liebig cooler on a very large scale.

The pipes extend for several hundred feet to the receiving house, from which the oil is conveyed to storage tanks of boiler iron placed in convenient localities.

The first distillation is not continued to dryness, but is discontinued when the residue is of a certain consistence, suitable for burning, when the still is allowed to cool to 300° or thereabout, after which the tarry residue is pumped into receiving tanks and used as fuel. Near the large retort, there is one of different construction, which is continuous in its action. It holds 80 barrels, but the daily capacity is 300 barrels.

There are two stills heated by steam, and used for fractional distillation of the first distillate. The products pass through the same cooler, and are received in the receiving room, and passed to the different tanks.

The fractional distillation is managed by means of an appliance, called "observation boxes," in which the operation can be seen. At the proper time the distillate, when it has attained a certain gravity, is diverted into different pipes leading to receiving tanks. The observation boxes are of plate glass.

There are fourteen receiving tanks of various sizes, one being devoted to the storage of oils from Santa Cruz County—others for the southern counties.

In one part of the inclosure are two elevated tanks, in which the oils are mixed with chemicals, by which they are refined. In octagonal buildings, with glass set in the roof and sides, there are two bleaching tanks, with a capacity of one thousand barrels each, in which the refined oils are exposed to the sunlight for a time, which is one operation in the process of refining.

In the boiler-house there are two large boilers, heated by refuse petroleum, blown in by a jet of steam and ignited. The consumption of carbon is so perfect that no smoke is seen to escape from the chimneys.

Mr. Miller made some experiments in the direction of burning brick by petroleum fuel, with only partial success; but the results of the experiments were such that he thinks the next will succeed, and that the cost of burning brick will be much abridged.

The Pacific Coast Oil Company have not succeeded in supplanting the eastern market, but have stopped the importation of lubricating oils, naphthas, and benzines to the extent of one third. From the fuel tanks a portion not required for burning, including "bottoms," is at intervals pumped into six stills, heated by open fires, from which a heavy lubricating oil is driven over, leaving in the still at pleasure either a pure asphalt or a coke. The coke has the appearance of the finest coke from the manufacture of coal gas, and the asphaltum is free from sand and suitable for many purposes, including the manufacture of varnish for the protection of iron. The lubricating oil is kept in a large cylindrical horizontal tank of boiler-iron partly imbedded in the ground.

The works are situated on the Southern Pacific Coast Railroad, from which a branch extends to the warehouses. The near proximity of the shores of the bay not only affords an escape for refuse, but gives facility for the approach of barges and sea-going vessels.

GEOLOGY OF THE CALIFORNIA OIL REGIONS.

My examination of the more important localities at which petroleum occurs in California was necessarily made with such haste that it would be premature attempting at this time to write much on the subject of their geology. It is to be hoped, however, that leisure and opportunity will be found to make more thorough examinations thereof in the future. Pico Cañon and Tunitas Creek offer special facilities for making geological sections, the rocks here lying in such positions that they could be readily measured.

As shown by the fossils collected, the localities visited belong to the tertiary age. The sedimentary rocks observed are highly interesting, and will hereafter be carefully studied. At Pico Cañon the sand rocks are stratified with much regularity, and are interstratified with plates or seams of gypsum (selenite), as seen also at Temple Street cut in the city of Los Angeles. There occur here, also, a black shale and a coarse conglomerate, but no fossils were noticed in the vicinity of the wells, though some are to be found at a short distance. There is evidence that this neighborhood has at some period been subjected to violent water action. That this happened at irregular intervals is shown by the unequal thickness of the various strata, and the material of which they are formed, some being quite thin and consisting of the finest river silt, while others are much thicker and composed wholly of coarse gravel. They were originally, no doubt, deposited on the bottom of a tertiary sea, and very likely at the mouth of some great "dead river." They were afterwards folded, and at a still later period, broken, as we now find them. In color this rock varies from gray to distinct yellow. Specimens were obtained and preserved for chemical and microscopic examination and study.

At the west end of the San Fernando tunnel, two miles south of Newhall, a sedimentary sandstone, similar to that noticed at San José, Los Angeles, and Pico Cañon, crops boldly, and can be seen in passing on the cars, extending for many miles. This sandstone abounds with fossils. They also appear plentifully in a cut made by a small creek near by, in the bed of which lie exposed bowlders, gravel, fine sedimentary silt, and a coarse highly ferruginous conglomerate, which latter, in decomposing, has imparted much iron to the water. The rocks here have been stained a deep red color. Fossils are noticeable also at the south end of the San Fernando tunnel, which has a length of 7,678 feet. In this cañon a thin seam of lignite has been exposed. The surface of the water where, standing in stagnant pools long, is covered with a scum of oil.

This variety of sandstone underlies the city of Los Angeles, where, from time to time, petroleum in small quantities has been met with. The water obtained in a well being sunk for the soap and chemical works of Mr. E. C. Niedt, at the time I was in that city (May, 1884), was found to be mixed with oil. The sedimentary rocks, as seen at the Temple Street cut, dip 56° S.E. nearly, and strike nearly S.W. At another point they incline 58° to the S.S.E. They strike at right angles with the dip; the stratification being wonderfully regular, with seams of selenite, as at Pico Cañon and Petrolia. At Tunitas Creek, San Mateo County, near the oil wells, the road cuts through a stratum of loose, rounded bowlders, full of fossils—*Pecten pabloensis.* The creek near Lobitas Station has eroded a fine sedimentary silt formation, rich in fossils, and which, extending westward, terminates on the seashore in a bluff seventy-five feet high, where again this same class of organic remains appears.

There is at Moody Gulch, Santa Clara County, nothing in the surface geology to indicate the source of the petroleum found at that place. The formation consists mainly of sand, gravel, and fragments of a soft yellow sandstone, samples of which were taken for the Museum. This sandstone resembles some found on Russian and Telegraph Hills, in San Francisco. I was unable to obtain here any fossil remains, nor could I learn that any had ever been observed by others. On the road below the wells is a cropping of this rock, which here has evidently been much disturbed. In the hill, which rises some two hundred feet above the upper well, the sandstone is found only in broken pieces, though the workmen report a ledge on the other side of the summit. There is here, also, so far as my observation extended, an absence of fossils.

FOSSILS FOUND IN THE CALIFORNIA OIL REGIONS.

The following comprises the fossils observed in the examination of the California oil regions:

At Snow's Well, near Petrolia, Los Angeles County, broken tooth of shark, *Carcharodon* sp.; and (5651), *Lucina borealis*, Lin. Pliocene.

At Sargent's, Santa Clara County, with asphaltum (5650), *Crassatella collina*, Con. Miocene; (5649), *Arca microdonta*, Con. Miocene; and (5647), Tapes stanleyi, Gabb, Pliocene.

Lobitas Station and Bluff, on the seacoast, San Mateo County (5645), *Saxidomus gibbosus*, Gabb, Pliocene; (5649), *Arca microdonta*, Con. Miocene; (5648), *Pecten pabloensis*, Miocene.

Oil wells, Tunitas Creek, same county (5648), *Pecten pabloensis*, Miocene.

The fossils found near Newhall, Los Angeles County, have not yet been determined, though they belong, without much doubt, to the tertiary.

SAMPLES OF OILS AND ASPHALTUM.

Below is given tabular statement of oils and asphaltum gathered and placed in the State Museum:

Catalogue Number.	Specific Gravity.	Description.	Locality.	Township and Range.	Degrees Beaumé.	Proportion of Sand and Impurities.
5633	1.143	Maltha	Tar Creek, near Sargent's, Santa Clara Co.			
5634		Asphaltum	Tar Creek, near Sargent's, Santa Clara Co.			
5635		Asphaltum, refined	Tar Creek, near Sargent's, Santa Clara Co.			
5636		Asphaltum, refined	Tar Creek, near Sargent's, Santa Clara Co.			
5637	1.15	Asphaltum, pure	Tar Creek, near Sargent's, Santa Clara Co.			
5638		Bréa	Petrolia, near Anaheim, Los Angeles Co.	Sec. 5, T. 3 S., R. 9 W.		56.8 per ct.
5639	.969	Maltha	Petrolia, near Anaheim, Los Angeles Co.	Sec. 5, T. 3 S., R. 9 W.	15°	
5640	.920	Maltha	Puente, Los Angeles Co.	Sec. 1, T. 3 S., R. 10 W.	22°	
5641	.795	Petroleum Green Oil	Tunitas Creek, San Mateo Co.	Sec. 25, T. 6 S., R. 5 W.	46°	
5642	.830	Petroleum Green Oil	Pico Cañon, Los Angeles Co.		39°	
5643	.797	Petroleum Refined	Pico Cañon, Los Angeles Co.		46°	
	1.81	Petroleum, in sand	7 miles from Santa Cruz, Santa Cruz Co.			80.2 per ct.

The production of petroleum in California, from 1878 to date, in barrels of 42 gallons, is here given, the yield of the first five years being taken from *Mineral Resources of the United States*, Albert Williams, Washington, 1883:

1878	15,227
1879	19,858
1880	42,399
1881	50,000
1882	70,000
1883 } 1884 }	190,540
Total	388,024

Cost of oil, 33° to 40° B., to the Los Angeles Electric Light Company, is $2 50 per barrel.

Newhall light refined oil sells for 6 cents per gallon at refinery. At Los Angeles, Puente, and Petrolia, crude oil commands 10 to 25 cents per gallon.

We have been heavy importers of petroleum, home requirements in this line having always been large, while a great extent of outside territory has been supplied from San Francisco.

Receipts at this port from the Eastern States amounted last year to 304,785 cases, besides considerable quantities received overland at interior towns.

The distribution from this point has for many years past ranged from two to four million gallons per annum, the quantity sent out last year having exceeded the latter figure. The annual consumption of California, Oregon, and Washington Territory, may be set down at 4,000,000 gallons, the demand for these countries undergoing rapid enlargement. Our exports of petroleum go mostly to British Columbia, Asia, and Asiatic Russia, with a little to Tahiti, Mexico, South America, and other of our neighbors. We shall probably be able in the course of a year or two more to supply the product of our California wells to not only these countries, including all the islands of the Pacific, but to the entire coast, from Cape Horn to Behring's Strait, and eastward to the Rocky Mountains, nor can we see any reason why we should not in time command the markets of the Orient.

THE OUTLOOK.

Everything considered, the prospects of the petroleum business in California may be pronounced highly encouraging. Having met with some disappointments at first, our people, being then largely engaged in mining for the precious metals, dropped the oil business, and for a number of years gave it little or no attention. Returning to it now, they are embarking in this industry with their usual energy—a guarantee that our petroleum deposits will, after the manner of our gold and silver mines, be worked to their fullest extent.

107. PETZITE. Etym. *Petz*, the chemist who first analyzed it. See, also, Tellurium.

This mineral is a variety of Hessite (which see), being a telluride of silver and gold; the latter metal replacing part of the silver. It is of too rare occurrence in California to have any practical value aside from the gold it contains, and interesting only as being an associate of gold.

An analysis of a specimen from the Stanislaus mine, Calaveras County, afforded Kustel:

Tellurium	35.40
Silver	40.60
Gold	24.80
	100.80

While this analysis shows the mineral to be rich in gold, it is so rare that only very small specimens can be obtained, and these but seldom. It occurs with the other tellurium minerals which constitute but a very small portion of the vein matter.

The following localities are known: Stanislaus and Melones mines in Calaveras County; Morgan mine, Tuolumne County.

108. PHOSGENITE. Etym. *Phosgene*, Light Producer. Chloro-Carbonate of Lead.

A single specimen has been found in quartz from the Silver Sprout mine, western slope of the Sierra Nevada, Inyo County. Straw-colored, acicular interlaced crystals in cavities (Aaron). Determination by C. Ide.

Phosphate of Lime—see Apatite.

109. PICOTITE. Etym. *Picot de la Peyrouse*, French chemist. Chrome Spinel.

Has been found by Dr. M. E. Wadsworth in the basalts of Mount Shasta; "Summary of the Progress of Mineralogy in 1882"—H. C. Lewis.

Picrolite—see Serpentine.

Platiniridium—see Platinum and Iridium.

110. PLATINUM. Etym. *Plata*, Silver. See, also, Iridium.

Platinum is one of the elements, a metal first found native in the gold sands of the River Pinto, District of Choco, South America, where it was named *platina*, a derivative of *plata* (silver), which it resembles. It was brought to Europe in 1741, at which time it was known as "*platina del Pinto*." The ore (if this is a proper term) was examined by the noted chemists of that day, who soon found it to be composed of a number of new minerals, which are now called the *platinum group*.

Platinum is found generally in placers like gold, usually in grains, plates, or irregular lumps, rarely in octohedrons or cubes. H=4—4,5; sp. gr.=16—19; luster and streak metallic; color and streak, steel gray; opaque; sometimes magnetic; infusible. Analysis finds it generally to contain as an alloy or mechanical mixture, gold, copper, iron, iridium, rhodium, palladium, osmium, sand, etc.

For a long time platinum was considered to be infusible, but now, by means of the oxyhydrogen blowpipe, it is melted without difficulty into bars weighing 75 pounds, or more. At the intense heat required in this operation, most of the impurities are volatilized, and thus got rid of. Metallic platinum in form suitable for economic use was formerly obtained by forging. To produce pure metallic platinum, the metal was dissolved in nitro-muriatic acid, precipitated by chloride of ammonium, and heated to redness. The spongy platinum thus obtained, was placed in a tube of iron, or brass, and while red hot, compressed by driving down the tube an iron plunger. The mass so obtained was then heated and hammered on an anvil until it became compact and suitable for drawing into wire, or rolling into sheets. An elaborate account of this operation may be found in Ure's Chemical Dictionary, published in 1820, folio 684. Platinum is used in the arts in the form of vessels, crucibles, wire, and foil, in the chemical laboratory for accurate weights and measures, dishes and tanks in which to boil or distill acid, or to make pickles, instead of in copper, the former method, syphons for drawing off hot or corrosive acids, spatulas, and cocks, and with iridium for vents of heavy ordnance, points of lightning rods, etc. The salts of platinum have their uses in chemistry.

Platinum is rather abundant in California with other metals of the group mentioned under the head of Iridium. The miners call it "white gold," and generally believe it to be more valuable than that metal, declining to save it when informed that it can only be sold for two or three dollars per ounce.

Platinum, with iridium and associated metals, is found in considerable quantities in Trinity County. At Hay Fork, a large stream in that county, all the gold found is more or less mixed with the platinum metals; so much so that dealers deduct two dollars per ounce from the price paid elsewhere for gold dust. At North Fork of Trinity River, platinum is found in less quantities, but in larger pieces. One was once offered for sale in Marysville which weighed over two and a half ounces troy.

Although platinum occurs in the river beds, and on the banks of the streams, yet in the so called "hill claims," about half a mile only from the river, no trace of that metal has been found. In lower Trinity, near its junction with the Klamath, platinum abounds in very fine particles; and it is with this finely divided platinum that Professor Wöhler discovered diamonds.

The metal is so abundant that the miners have the utmost difficulty in separating it from the gold. The particles are so extremely fine that they can hardly be distinguished from the black sand which accompanies the gold. Heretofore no effort has been made to place the platinum in the market, except the sending to San Francisco of 100 ounces or more, a few years ago. It could, probably, be sent to Europe to advantage. In Salmon River it is also found. In fact, it is common in the beds of the streams in Sierra, Trinity, Klamath, and Del Norte Counties.

Platinum (1521) is found with iridium, cinnabar, zircons, and gold, in Anderson Valley, Navarro River, Mendocino County; at Gopher and Badger Hills, Plumas County (Edman).

(1892) with platiniridium. In a claim three miles from Trinity Center, Trinity County; and with gold, zircons, diamonds, and other minerals from Cape Blanco to Cape Mendocino, on the ocean beach.

Mr. A. Hewett found several large pieces of platinum in 1851 on Nelson Creek, Plumas County. The largest was the size of a large bean.

Mr. Block, of San Francisco, said that large pieces have been found on North Fork of Trinity River; one piece weighed two ounces. The miners in washing gold in long sluices got the gold by the aid of quicksilver, and the platinum minerals remained in the riffles.

Platinum is found rather abundantly in Butte County. Considerable quantities were recovered in the clean-ups at the Spring Valley hydraulic mine, Cherokee, and at St. Clair Flat, near Pence, large quantities were found in the early days of placer mining.

If the miners could be persuaded to collect the platinum minerals, an industry might be established of considerable importance. There is no reason why platinum should not be manufactured in San Francisco and the American demand in part or wholly supplied by this State. The process of manufacture is simple, the plant required inexpensive, and there are skillful chemists in the State fully competent to manage it. The control of the platinum trade is in the hands of a single English manufacturing firm, which has been the case for many years.

Platinum is largely produced in Russia. The following is an official table of the production. (1 poud equals 526.64 troy ounces; 1 livre, 13.166 troy ounces; 1 zolotnick, 1,364 troy ounces):

Years.	Pouds.	Livres.	Zolotnicks.	Years.	Pouds.	Livres.	Zolotnicks.
1867	109	9	56	1872	94	39	68
1868	122	23	47	1873	96	9	85
1869	142	39	91	1874	122	39	42
1870	118	38	33	1875	94	7	44
1871	125	6	56	1876	96	8	48

111. POLYBASITE. Named from the Greek—*Many Bases*—it being a sulphide of many bases, viz.: antimony, arsenic, copper, iron, silver, and zinc.

It is a rare mineral in California, being found only in small microscopical crystals in the Morning Star and Monitor mines, Alpine County.

112. PRICEITE. Etym. *Price*, San Francisco chemist.

In October, 1871, Lieutenant A. W. Chase brought to the Academy of Sciences of San Francisco a sample of chalky substance, which he thought to be magnesia. A small sample was given to me for examination, which I turned over to a pupil, Mr. E. J. Shipman, who spent some time over it, and reported it to be borate of lime. Never having seen borate of lime in this form, I requested him to repeat his experiments, which he did, and with the same result. I then made an examination of the mineral myself, both chemical and microscopical, which led me to class it with *cryptomorphite*. The appearance under the microscope was so characteristic that I had no doubt as to its identity. At the evening meeting, November sixth, Lieutenant Chase presented it to the Academy of Sciences. Subsequently two samples were analyzed by Thomas Price, of San Francisco, which gave the following result:

	1.	2.
Boracic acid	47.04	45.20
Lime	29.96	29.80
Water	22.75	25.00
Alkalies	.25	Traces.
	100.00	100.00

In 1873, Professor Silliman made a study of this mineral, and obtained the following mean of three analyses:

Boracic acid	49.00
Lime	31.83
Water	18.29
Alumina, salt, and oxide of iron	.96
	100.08

The absence of soda separates this mineral from ulexite and cryptomorphite, and seems to make it a new species, named as above by Professor Silliman. After studying this mineral and examining many specimens, I am led to believe that it is changed from ulexite by the abstraction of the soda and part of the water. I have a specimen of pandermite, which has undoubtedly changed from a ulexite "cotton ball."

PANDERMITE

Is a variety of priceite. The following extract from the London *Journal of the Society of Arts*, August 6, 1880, by C. C. Warnford Lock, affords all that is known relating to this mineral:

I have now to deal with a new commercial borate, which, on the score of geographical position, abundance, cheapness of working, and easy manipulation, is certainly destined in a great measure to rule the markets of Europe, and particularly of Great Britain.

The new field lies on the Tchinar-Sau, a small stream feeding the Rhyndacus River, whose outlet is in the Sea of Marmora, near the port of Panderma, on the Asiatic shore. It embraces the villages of Sultan-Tchair, Yildiz, and Omerli, and the guard-house of the Demircapon pass. The area of the field is computed at over 13,000 acres (20 square miles). Its eastern confines nearly abut upon the Rhyndacus, which has been navigated by steamers up to a point called Balakeser. A company has been formed for deepening and improving the stream, and a railway has been projected from Panderma to Balakeser. The wagon road has hitherto been utilized for transporting the mineral, the distance from Panderma to the western edge of the field being about forty English miles. The port of Panderma is regularly frequented by local steamers, and offers every convenience for shipping.

The field is situated in a basin of tertiary age, surrounded by volcanic rocks, which vary from granite on the east to trachyte on the north, and columnar basalt on the west. Several basaltic hills and dikes protrude in different portions of the basin, and the presence of hot and mineral springs further testifies to the volcanic influences which have been at work, and in which, doubtless, originated the boracic mineral. The latter occurs in a stratum at the bottom of an enormous bed of gypsum, its greater specific gravity probably impelling it downwards while the whole mass was yet in a soft state. Several feet of clay cover the gypsum bed, which is here 60 to 70 feet thick, though in places it attains to double that thickness.

The boraciferous stratum varies in depth; it has been proved for a vertical distance of forty-five feet. The mineral exists in closely-packed nodules, of very irregular size and shape, and of all weights up to a ton. Vom Rath has named it "Pandermite," from the port of shipment.

In outward appearance it closely resembles a snow-white, fine-grained marble. Chemically speaking, it is a hydrous borate of lime, its composition being expressed by the formula $2CaO, 3B_2O_3, 3H_2O$; in other words, it consists of boracic acid 55.85 per cent; lime, 29.78 per cent, and water 14.36 per cent. Its richness in boracic acid is at once apparent, and places it high above the other commercial borates. Thus ordinary borax (borate of soda) contains only 36.58 per cent of the acid; boro-calcite and boronatro-calcite (borates of lime and of lime and soda) vary from 8½ per cent up to 46 per cent, and average about 40 per cent, boracite and stassfurtite (borates of magnesia), containing respectively about 63 per cent and 60⅞ per cent, alone surpass it in this respect, and they can hardly be deemed commercial minerals. After very simple preparation pandermite can be very directly applied as a flux, and is more economical than borax for this purpose, thanks to its larger proportion of boracic acid.

An outcrop of the mineral was discovered by a foreigner some years since, and the bed was secretly worked; small shipments were occasionally made to Europe under the denomination of plaster of Paris, thus keeping the matter hidden, and at the same time avoiding the payment of dues and duties. The Ottoman Government has since been apprised of these irregularities and has taken energetic measures to correct them. More recently it has granted a comprehensive concession to a party of British residents, who are setting to work to develop the property. The district enjoys the great advantage of being under British protection.

The workings were at first placed under that section of the Réglement des Mines relating to quarries, but have since been transferred to the section regulating mines proper. Steps are being taken to open up the deposit in a systematic manner, by first sinking a number of bore-holes—as has been done with the Kainit beds at Stassfurt—to ascertain the points of greatest development in the basin. The locality possesses a healthy climate, except in the Autumn, when there is some ague.

Labor is very cheap and abundant, Turks, Armenians, Greeks, Circassians, Tartars, and Italians being obtainable from the neighboring villages. There is a supply of water; oak and fir timber may be procured at six to seven miles distant, and scrub for fuel covers the surrounding hills.

The actual cost of the mineral, as now worked, is as follows:

Raising and dressing (exclusive of cost of tools)	10.0 paras per oke
Transport to Panderma	9.0 paras per oke
Custom duty, 1 per cent ad valorem	.5 paras per oke
Management and other charges	2.5 paras per oke
Total	22.0 paras per oke

	£	s.	d.	
At 795½ okes per ton, and 128¼ piastres per £ sterling (1 piastre=40 paras) this will equal	3	8	3	per ton
To this must be added the government royalty, 5 per cent ad valorem, say	0	5	0	per ton
Contingencies	0	10	0	per ton
Freight and insurance	0	15	0	per ton
Making a total cost, "c., f., and i."	£4	18	3	per ton

The present values of the boracic products now in the market vary from £46 to £60 per ton, according to quality; the lowest figure ever reached here has been about £20 a ton, at which price the demand would immensely increase.

Pisani, of Paris, analyzed this mineral and obtained the following result:

Boracic acid	50.1
Lime	32.0
Water	17.9
	100.00

It will be seen as stated elsewhere that the variety pandermite has recently been found in apparent abundance in Death Valley, Inyo County, and at Calico, San Bernardino County, and the cryptomorphic variety also at the latter locality.

COLEMANITE

Is also a variety of priceite found recently in Death Valley. The following analysis was made by Thomas Price, of San Francisco, March, 1883, by whom the original priceite was first analyzed:

Anhydrous boracic acid	48.12
Lime	28.43
Water	22.20
Alumina and oxide of iron	.60
Silica	.65
	100.00

In the above analysis, the alumina, iron, and silica are probably mechanical impurities—1.25 being added proportionately to the other constituents, gives the following percentage:

Boracic acid	48.72
Lime	28.79
Water	22.49
	100.00

This gives the approximate formula $4Bo_3$, 3CaO, 6HO, being the same obtained by Silliman for priceite, which no doubt it is in a crystalline state. As this mineral possesses certain physical properties differing from priceite, a name has been given to it to distinguish it from the soft chalky mineral found both in southern Oregon and San Bernardino County, California.

The name *colemanite* was given by the discoverer of the mineral in honor of William T. Coleman, of San Francisco, who has been identified with the borax interests of the Pacific Coast from the commencement.

PROPERTIES OF COLEMANITE.

Color and streak white; milky to transparent; hardness 3.5—4; specific gravity, 2.39; before the blowpipe, it exfoliates, decrepitates violently, and melts imperfectly; after considerable heating it imparts a reddish yellow color to the flame, which changes to green. The mineral pulverizes easily, fragments obscurely rhombic. It is wholly soluble in hydrochloric acid with heat. From the solution boracic acid crystallizes on cooling. The filtrate gives a white precipitate with ammonia and oxalate of ammonia. With sulphuric acid, or with fluorspar and bisulphate of potash, tinges the blowpipe flame green. Luster of the mineral vitreous to adamantine. It shows no perfect crystals, but appears like semi-crystalline calcite.

The above is copied from the third annual report. Since it was published, colemanite has been found in magnificent crystals. In experiments made in my laboratory, it was found to be wholly soluble in dilute hydrochloric acid without effervescence. By a practical test, 30.4 per cent of anhydrous boracic acid was obtained from the first crystallization. The crystals of colemanite are monoclinic, and so strongly resemble those of datholite, that Professor G. Vom Rath, of the University of Bonn, who was in San Francisco when the first crystallized specimens came to hand, expressed surprise at the great similarity. He will study the crystallography carefully on his return to Germany, and will publish figures.

113. PROUSTITE. Etym. *Proust*, French chemist. Light Ruby Silver Ore.

Arsenical sulphide of silver, found sparingly in the Chicago mine, Shasta County, with galena, pyrite, and quartz, between walls of granite (Aaron). No. 4951, in the State Museum, from the Oro mine, Bodie, Mono County, shows it in crystals, with pyrargyrite in quartz.

114. PSILOMELANE. Etym. *Bare* and *Black* (Greek).

A hard black mineral, supposed to be psilomelane, is found in several localities in the State, with pyrolusite and rhodonite, but no analysis has been made to prove it. This mineral differs from pyrolusite in containing baryta and oxide of manganese, and more water. It has been found at Spanish Ranch, Plumas County, on Red Rock, Bay of San Francisco, and in quartz, Santa Ana River, Los Angeles County. No. 1671, in the State Museum, was mistaken for tin ore.

Pumice Stone—see Orthoclase.

115. PYRARGYRITE. Etym. *Fire Silver* (Greek). Dark Ruby Silver, Antimonial Sulphide of Silver.

This mineral, like proustite, is rare in California. It has been found in the Exchequer mine, Alpine County, and with proustite, No. 2451, State Museum, in the Oro mine, Bodie, Mono County.

116. PYROLUSITE. Etym. *Fire-wash* (Greek). Binoxide of Manganese.

Color and streak, black. H=2—5.5. Sp. gr. 4.82. Brittle. Opaque. Composition ($Mn\ O_2$).

Manganese	63.3
Oxygen	36.7
	100.0

B. B. infusible. Non-magnetic.

May be readily distinguished. If pulverized in an agate mortar and wet with hydrochloric acid, chlorine is set free, which can be recognized by its suffocating smell, an odor different from that of the acid alone. If heated in a closed tube oxygen is given off, and if a match is lighted and blown out the live coal at the end of the match brightens and scintillates, if held near the mouth of the tube (oxygen). A small portion of the pulverized mineral imparts to borax an amethyst color, if heated B. B. in loop of platinum wire. This very important and valuable mineral is found in great abundance in California at numerous localities. Its uses may be enumerated as follows: In the production of chlorine gas, extensively used in the manufacture of chloride of lime (bleaching powder); in extracting gold from roasted auriferous pyrites; and as a disinfectant; for the production of oxygen gas; and largely in ferro-manganese, essential in the manufacture of steel and soft iron by the Bessemer process. It will be seen that it contains no chlorine. Still this gas is nearly always set free by its use, at the expense of the hydrochloric acid or salt (chloride of sodium) employed with it. The second equivalent of oxygen in the mineral has but a feeble affinity, and leaves it when heated, as in the experiment with the closed tube and match, leaving behind oxide of manganese ($Mn\ O$). It also passes to any element for which it has a greater affinity, as for example, to the hydrogen of the hydrochloric acid in the first experiment, setting the chlorine free. When salt is used, sulphuric acid is employed; these reactions will be understood by studying the following equations:

1. $Mn\ O_2$ strongly heated$=Mn\ O+O$.
2. $Mn\ O_2+HCl=Mn\ O+HO+Cl$.
3. $Mn\ O_2+Na\ Cl+SO_3=Mn\ O+NaO\ SO_3+Cl$.

Ferro-manganese is made by heating from 30 to 60 pounds of a mixture of pyrolusite, charcoal, and finely divided scrap iron, to a white heat, in crucibles. The alloys contain from 66 to 80 per cent of manganese. When the projected iron works are built (see Iron), pyrolusite will come into demand and be utilized. It has been employed for years in the chlorination process before mentioned, and some has been shipped to England and the Eastern States. The word pyrolusite, meaning *fire wash*, is given from its being used to remove objectionable colors from glass in its manufacture. It is called by the French, for the same reason, "*savon des verriers*" (glass-makers' soap). The known California localities are:

Alameda County. No. 4900, State Museum.

Calaveras County, near Angel's. No. 1170. Railroad Flat, No. 5053.

Contra Costa County. Corral Hollow—abundant.

Marin County. Near Saucelito, and near Tomales.

Napa County. St. Helena Mountain. No. 4337.

Nevada County. Sweetland.

Plumas County. Argentine and Mumford's Hill (Edman).

San Bernardino County. With rhodonite, near Colton.

San Francisco Bay. Red Rock. San Francisco County. Bernal Heights, San Francisco.

Santa Clara County. Hahn's ranch, 12 miles south of the Guadalupe quicksilver mine. No. 4965.

Sonoma County. Near Cloverdale. Nos. 3772, 5107, State Museum. Santa Rosa. No. 2337.

Tuolumne County. Knight's ranch, near Columbia, in botryoidal and mammillary masses, from the size of a grape to 100 pounds in weight, on the surface of the ground. No. 4124. With rhodonite two miles south of Summerville. No. 3657.

117. PHYRRHOTITE. Etym. *Reddish* (Greek). Magnetic Pyrites.

Found in Mariposa County, at the Iona Copper Company's tunnel, north side of the Merced River, on the trail from Bear Valley to Coulterville (Blake).

118. PYRITES. Etym. *Fire* (Greek). Pyrite, Sulphuret of Iron, the "Sulphurets" of the gold miner, Mundic, Martial Pyrites. See, also, Marcasite.

Color, pale brass-yellow, streak greenish, or brownish black. H=6—6.5. Strikes fire with steel, whence the name; opaque, fracture conchoidal, brittle. Composition ($Fe\ S_2$).

Sulphur	53.3
Iron	46.7
	100.0

In closed tube gives sulphur as a yellow sublimate above the assay, and a magnetic residue. If pulverized and thrown on hot coals, or red-hot iron, it gives off fumes of sulphurous acid, smelling like a burning match. It generally contains gold, and in California is seldom wanting in auriferous quartz, except in oxidized ores lying above the water line, in which case the crystals of pyrite are changed to limonite, often specked with gold. In some mines, nearly all the gold is in the sulphurets, and is sometimes obtained after mechanical concentrations, by the "chlorination process." The ore is first roasted in a reverberatory furnace, always letting the sulphur go to waste. It is then dampened with water and placed in a large wooden tub with perforated false bottom, upon which coarse cloth is laid. Chlorine gas is generated (see Pyrolusite), and conducted in a lead pipe to the bottom of the tub below the false bottom, until the mass is saturated with the gas, after which it is closely covered, and allowed to stand for several days. It is then leached with cold water, sprinkled over the surface by a hose. After some time, a greenish-yellow fluid begins to flow from a small aperture at the bottom of the tub, which is carefully collected in glass vessels, generally boxed carboys. This fluid contains the gold. The sprinkling is continued until the water flows off colorless, and gives no reaction for gold when treated as described below. Solution of proto-sulphate of iron is added to the contents of the carboys, with frequent shaking, as long as a black precipitate falls. After standing for a time, the liquid and precipitate are decanted on paper filters in glass funnels; the worthless liquid filters through, leaving the gold precipitate on the paper. The filters are dried and rolled up into wads, or balls, and placed in succession in a crucible, kept in a high heat in a bullion furnace. Fluxes are added from time to time, until the gold is melted, when it is poured into an iron ingot mold in the usual manner. This process, so extensively practiced in the State, has been found to be wasteful and unsatisfactory, and will, no doubt, eventually be replaced by one in which the sulphur and iron will be saved, and also more of the gold. This subject has been mentioned elsewhere in this report, and is one of great importance. Pyrite is one of the most abundant of the minerals of the State, and is represented in the State Museum by many localities. The specimens are so numerous that it is hardly worth while to mention them all here. Auriferous sulphurets often contain barite, bornite, calcite, cinnabar, chalcosite, chalcopyrite, native copper, enargite, fluorite, galena, marcasite, mispickel, molybdenite, quartz, roscoelite, silver minerals, siderite, sphalerite, stromeyite, tellurium, and other minerals. The gold quartz worked in California contain from one to five per cent of sulphurets; when concentrated, they assay from one hundred to three hundred dollars per ton, although the gold saved in the mill might not have exceeded from six to ten dollars per ton. A very interesting table of analyses, from different mines, may be found in Dr. Trask's report for 1856, folio 60. The table shows that the loss was very great at that time. Pyrite is often mistaken for gold by inexperienced prospectors. In 1847, the ship "Brooklyn," of New London, Captain Carroll, was whaling in Magdalena Bay, Lower California. The crew discovered what they thought to be gold in vast quantities. Several ten barrel pipes were filled with pyrites, and the men stopped catching whales, and sailed away for New London with a supposed fortune for the owners and all on board. Of the numerous localities of pyrite in the State, the following are worthy of special mention, or are represented in the State Museum:

Alpine County. Morning Star mine, with enargite.

Amador County. Jackson, No. 653.

Calaveras County. E Pluribus Unum mine, three miles from Murphy's (Blake).

El Dorado County. Brilliant cubes, Mameluke mine, near Georgetown (Blake). Pilot Hill, in large cubes, with garnet-brown spar and specular iron (Blake). In crystals with gold (3701), with quartz, both crystallized.

Inyo County. Modoc mine (1649).

Mariposa County. In slates, in large and perfect crystals, near Princeton Hill (Blake).

Mono County. No. 2128.

Napa County. With cinnabar, Redington quicksilver mine, No.

1505, very fine. In cavities in quartz, cubical crystals, Knox & Osborn quicksilver mine, No. 4338.

Nevada County. Grass Valley, massive, with chalcopyrite, San Francisco copper mine, Spenceville, No. 4386. Massive, with gold, Meadow Lake District, No. 4357. Taking the form of wood, with hematite, Occidental mine, Scott's Flat, No. 1515. With calcite, Malakoff mine, North Bloomfield, No. 3394. In lignite, Malakoff mine, North Bloomfield, No. 3411.

Placer County. Globular, in calcite, near Auburn, No. 3671. Clipper coal mine, No. 4905, near Grizzly Bear House, Forest Hill, in large crystals (Blake). True Fissure mine, Devil's Peak Mountain, No. 2916. With lignite, Spink's coal mine, Lincoln, No. 981.

Plumas County. Granite Basin, Mumford's Hill, in crystals, with dolomite (Edman).

San Luis Obispo County. In cavities in the Sunderland quicksilver mine, No. 2348.

Shasta County. With pyrolusite and gold, Banghart mine, No. 1794. With erubescite and chalcopyrite, Copper City. In nodules, with sulphide of silver, very rich, Nos. 1710, 1711, 4140.

Tuolumne County. In fine crystals, Patterson mine, Tuttletown.

119. PYROPHYLLITE. Etym. *Fire Leaf* (Greek).

This mineral, a hydrous silicate having no economic value, but which is interesting from a scientific standpoint, is found in beautiful radiating tufts of a golden yellow color, at Greaser Gulch, or Indian Gulch, Mariposa County. It occurs in large bowlders on the surface of the ground, near two prominent buttes. This locality is represented by No. 3723 in the State Museum.

120. PYROXENE. Etym. *Stranger to Fire* (Greek).

A silicate of different bases, the varieties of which are known under different names, as augite, diopside, sahlite, omphazite, hypersthene, diallage, smaragdite, etc.

This mineral enters largely into the composition of igneous rocks. In this form it is probably largely distributed in California. It is found in fine dark green crystals near Mud Springs, El Dorado County (Blake), and also in fine crystals at the Cosumnes copper mine, in the same county.

121. QUARTZ.

Quartz is one of the most abundant minerals of the earth's crust, being found in the crystalline or primitive rocks, and in all the sedimentary ones resulting from their disintegration and decomposition. It assumes many forms and colors, from opaque quartzite to the purest rock crystal, superior to glass for optical purposes; from black to snow-white, amethyst, or rose color. The varieties are known by many names, among which are agate, amethyst, aventurine, blood stone, Brazilian pebble, buhr stone, carnelian, cat's-eye, chrysoprase, cairngorm, false topaz, heliotrope, jasper, mocha stone, onyx, prase, quartz and quartzite, rock crystal, siderite, sardonyx, etc.

Quartz is colorless when pure, otherwise blue, green, brown, red, yellow, black, and variegated; fracture conchoidal, brittle, crystals often inclosing impurities and foreign crystals, as chlorite, cinnabar, titanic acid, etc. When massive, often a matrix for gold, silver, galena, zinc blende, magnetite, and other minerals. Quartz is the principal vein matter of our best mines. Sp. gr. 2.5 to 2.8 H. 7; scratches glass easily, but is scratched by topaz. All varieties have nearly the same chemical composition and physical properties; the clear colorless crystals of quartz are often mistaken for diamonds. The fact that they are softer than topaz will serve to distinguish them from that gem. The color of the different varieties is owing to the accidental presence of the oxides of different metals.

The principal constituent of all these varieties is silica, or silex in its insoluble form; that is, not soluble in caustic soda solution. Before the blowpipe alone they undergo no change, but with soda dissolve with effervescence and form a transparent glass. Insoluble in acids. If previously fused with carbonate of potash and soda, they become soluble in hydrochloric acid.

Quartz is a binoxide of silicon ($Si\ O_2$), the elements being combined as follows:

Silicon	46.67
Oxygen	53.33
	100.00

Agate is a variety of chalcedony, generally in layers, sometimes clouded. Moss agate is chalcedony with dendritic crystals of oxide of manganese and iron imbedded in it, which take the form of vegetation. The ancient "achates" was probably fortification agate. Pyrrhus, who lived 318 years before Christ, is said to have had an agate of this kind, on which was represented, by the hand of nature, a picture of the Nine Muses as perfect as a work of art. Achates, from which agate was named, was an ancient town in Sicily. The moss agate was known to the ancients as dendracthates (dendritic agate).

AMETHYST

Is a purple red variety of quartz crystal, formerly supposed to owe its color to oxide of manganese, but specimens having been analyzed which contained no manganese, the color is now thought to be due to some peculiar compound of iron or soda. Rose quartz is a variety of amethyst only slightly tinged.

The amethyst was well known to the ancients and was highly prized by them. They gave this gem the name of "aphrodisiace," or gem of Venus. By some strange superstition they believed the amethyst to be a cure for drunkenness, from which the name is derived. A good well-cut amethyst of one carat is worth from three to five dollars. A large and fine stone of good color has been sold as high as five hundred dollars. The best amethysts come from Ceylon, Brazil, and Siberia. Good specimens are found on the shores of Lake Superior, in the quartz formation of the Comstock ledge, and at Grass Valley. The true amethyst must not be confounded with the violet sapphire, sometimes called oriental amethyst, which is much more valuable and of entirely different composition.

Aventurine is quartz, massive, of a pearly or reddish color, and containing thin plates or scales of mica, which give it a peculiar glimmering appearance, much admired in cut specimens. It is found in India, Bohemia, on the shores of the White Sea, and elsewhere. The best specimens come from Cape Gata, in Spain. The artificial aventurine is far more beautiful than the natural. A formula for making it is as follows: Heat together, for a long time, eight parts of ground glass, one part of protoxide of copper, and two of oxide of iron, and allow the mixture to cool slowly. An artificial production, said to come from Japan, is extremely puzzling. In cutting a thin section and examining it under the microscope, the spangles are seen to be perfect tabular crystals. Mrs. Captain Nathan, of San Francisco, has a magnificent specimen of this singular production.

The finest specimens of natural aventurine known, are two large vases cut from this rare mineral, which were presented by the Emperor of Russia to Sir Roderick Murchison. They are now in the Museum of Economic Geology, of London.

Bloodstone and heliotrope are names for the same variety. The color is deep green interspersed with spots of red, like drops of blood. Good specimens command as high as twenty dollars each. Heliotrope takes its name from having been used under water as a mirror to observe a solar eclipse. Pliny describes the heliotrope as being "prasius" which was "horrid with spots of blood."

Brazilian pebble is quartz crystal, or massive rock crystal, rolled and water-worn ; was first brought from Brazil. It is very valuable for making glasses for spectacles, being harder and more durable than glass. A good deposit of this mineral would be very valuable. The Japanese excel in cutting quartz or crystal.

There is a locality near Placerville where this valuable mineral is found, and which should be examined with a view to supply the market. Good clear pieces would find a ready sale in London or Paris.

No. 5931, in the State Museum, is a magnificent specimen of Japanese rock crystal, in the form of a sphere, two and a half inches in diameter. Sent by the Government of Japan in exchange for California minerals.

BUHR MILLSTONE.

"*Bur*"—old English for a whetstone.

This valuable mineral has been found at several localities in the State; one examined by the State Mineralogist a number of years ago, is a small outlier in Owen's River Valley, Inyo County, known as "Little Butte," which is a prominent landmark on the line dividing Russ from Inyo mining districts. It lies partly on section thirteen, township thirteen south, and range thirty-five east, and partly on section eighteen, same township, range thirty-six east. The stone is hard and brecciated, somewhat resembling the celebrated French buhr stone. A sample has been placed in the State Museum, No. 2189. Dr. J. B. Trask, first State Geologist of California, says in his first report, that it is found in great abundance on Pit River—in Modoc County—extending to the north of Goose Lake. The following quotation shows what importance he attached to the discovery:

> Its admirable adaptation to milling requires no comment. The value of this rock cannot be too highly esteemed in this State, where the prospective is so flattering of its becoming a grain-growing country equaled by few on the Atlantic slope. The heavy expenses that are now incurred, and the future wants of the State in this particular, will be obviated, and our dependent condition on foreign import destroyed. These rocks have as yet attracted little notice, but the rapidly increasing wants of the State will ere long bring them into requisition.

Most of the buhr stones heretofore used in the United States have been imported from France, Belgium, and Germany, whence they are brought in a partially dressed state. Some have also been quarried in New York and Pennsylvania. As metallic rollers are being largely substituted for buhr stones, the importance of the latter is likely to diminish in the future.

Carnelian is a clear bright red chalcedony. It takes its color from oxide of iron. Fine specimens come from Lake Superior. The first specimens found their way to us from Siberia, India, Arabia, Nubia, and the Tyrol.

Carnelian is sometimes diversified by stripes of white, and can be cut into beautiful jewelry. It does not command a high price, but good specimens find a ready sale. The sardonyx is a variety of carnelian, with stripes of white, of a thickness to admit of cutting into cameos. That is to say, by cutting away portions of the red, and leaving figures of red on a white base, or the reverse. A good sardonyx commands a high price.

Sardonyx.—The name sardonyx was the same anciently as now. It is the onyx in which some of the bands are carnelian. The first historical record of the use of this stone as a seal is the case of Scipio Africanus, from whose time it was much used, as it was found that the wax did not stick to it.

The ancient name for carnelian was "sard," because it was found at Sardes, an ancient town in Asia Minor, on the banks of the Pactolus. It was afterwards found near Babylon.

The name is derived from *carneus*, flesh, which it was supposed to resemble.

Chalcedony generally takes a mammillary or botryoidal form, often constituting a smooth lining of cavities. It is formed by a gradual deposit from water holding silica in solution. It takes its color accidentally from the substances it is thrown in contact with. The most beautiful color is a delicate pink, which is quite common at Aurora, Esmeralda County, Nevada. Chalcedony is named from Chalcedon, an ancient city in Bithynia, in Asia Minor. This mineral is also found in many beautiful forms at Volcano, Amador County; in Monterey County, near Panoches; on Walker River, Nevada; between Williamson Pass and Johnson's River, Los Angeles County, and in many localities in other parts of the world.

Cat's-eye is a translucent variety of quartz, which, when cut, presents a peculiar appearance, supposed to resemble the eye of a cat, whence its name. This peculiarity is owing to its being intersected by filaments of asbestos. Cat's-eye is found in small fragments in Ceylon, never in pieces larger than a hazlenut. Common varieties are sold for $20 or thereabout, while the best specimens command $100. "Beli oculus" was the ancient name for cat's-eye.

Prase and Chrysoprase always occur massive. The latter is of an apple or leek green color, which it takes from a portion of nickel it contains. It is translucent; luster, vitreous. It loses its color when heated. It is composed of silica, carbonate of lime, alumina, oxide of iron, and nickel. A good chrysoprase suitable for a ring is worth from $25 to $30. A remarkably fine specimen has been sold as high as $60.

The chrysoprase of the ancients resembled in color the juice of the leek, a golden color, whence its name.

Smoky quartz is known in commerce as cairngorm, from a celebrated locality in the Cairngorm Mountains in Scotland. It is common in California. The best I have seen came from near Placerville.

FALSE TOPAZ

Is a clear yellow variety of crystallized quartz. It resembles yellow topaz when cut, but may be distinguished by its hardness, which is less than that of true topaz, and by its specific gravity. Beautiful specimens are found occasionally on the Comstock, near Gold Hill, Nevada.

Jasper is always opaque and of a dull color. It is sometimes striped or clouded. It has a low value, but some varieties are very beautiful when cut and polished. It sometimes occurs in very large masses; luster sometimes resinous or like wax.

It scratches glass, but is scratched by a quartz crystal. Some very fine varieties of jasper occur near San Francisco. Jasper is always a metamorphic rock. It is generally the result of the action of heat on sandstone, which has been so changed as to lose the character of sand and become somewhat homogeneous. There is a specimen in the collection at the University of California from Knight's Ferry, showing the sandstone, one side of which has been changed to jasper. A fine variety of jasper is found near Murphy's Camp. It is of a brown color and beautifully variegated. Jasper under the name of "iaspis" was a favorite stone with the ancients.

Red and green jasper are common on the peninsula of San Francisco. Several hills in the southwestern part of the city consist mainly of jasper, slightly mixed with clay, etc. This rock is tolerably hard, and by reason of the facility with which it can be obtained, has for many years past been largely used in and about the city as a bedding for sidewalks, park paths, for filling between basalt blocks and cobble stones, and similar purposes, still more having been employed for paving suburban and little traveled streets, this material not answering well for those much used by heavily laden vehicles. In removing this rock extensive pits, or rather terraces, have been excavated from the sides of these hills, a perpendicular face nearly 100 feet high having been worked on some of them. After being broken out with pick and powder the rock is carted to the edge of the terrace and sent down through chutes into large bunkers fifty or sixty feet below, the smaller particles being separated from the larger by a screen in the bottom of the chute. From the bunkers it is hauled directly to the places where used, the coarser rock being placed below, and the finer on top, and, in the case of sidewalks, covered with asphaltum or concrete, this being necessary to make them sufficiently smooth. The passage of teams grinds up this material, which, if kept a little moist, impacts and makes a clean solid pavement. During the past few years of active improvement in the city, large excavations have been worked into the sides of these jasper hills, as many as 200 men having sometimes been employed getting out and carting away this rock, of which there is enough to last for all time to come. To call these pits mines, or this rock a concrete, as is sometimes done, is a misnomer, the former being nothing but open quarries, and the latter simply a crumbly sort of rock mixed with a little clay, but possessing none of the properties that distinguish a concrete.

Mocha-stone is quartz in which is imbedded irregular particles of the oxides of iron and manganese, different from the moss agate before described. It is found in Arabia, and is supposed to take its name from Mocha. Some very peculiar and beautiful specimens have lately been brought to San Francisco from the Aleutian islands.

Onyx is a variety of agate, in which stripes of white and black alternate. This stone is used in cutting cameos, the white portion being cut away so as to leave white figures on a black ground.

Quartzite is a rock consisting of impure massive quartz. Generally granular and often schistose, it is considered to be a mica schist, very poor in mica; or metamorphic sandstone. It is found in California in many forms and colors.

Siderite is Berlin blue quartz. It comes from Salzberg.

Quartz is too soft to rank high as a gem, but some of the varieties are held in esteem. It is not generally known that a fine amethyst soon becomes dull and almost lusterless if not often cleaned with soap and water. It is a good rule to wash such a stone frequently, with a small brush, and then to wipe it dry with a towel. The more noble gems do not require so much attention, but even they may sometimes be so improved.

QUARTZ JEWELRY.

Gold-quartz jewelry has become very common since the discovery of gold in California, so much so as to attract but little attention; although when first introduced it was much admired. It was difficult to obtain pieces suitable for this purpose while the demand continued. A magnificent specimen of this work was shown at the Paris Exposition of 1878. It was designed by A. Andrews for Mrs. M. A. Sunderland, both of San Francisco. All the work was done by San Francisco artists and artisans. It was exhibited in the United States section. The following description, in French and English, was printed in pamphlet form, and distributed by Mr. Thos. B. Oakley, of Paris:

From the private collection of Mrs. M. A. Sunderland, of San Francisco, California, United States of America.

These three works of art were made expressly for the Exposition in Paris, 1878, by order of this lady, the work having been executed by a jeweler of San Francisco.

The first is a *massive and elegant porte-monnaie and card-case combined,* made of solid gold, and the quartz rock beautifully designed in mosaic, interspersed with gold. The quartz rock comes from the mines of the States of California, Nevada, Arizona, and Washington Territory.

The second is a ladies' powder-box and puff, a very exquisite work of art and taste. This powder-box is composed of quartz rock from all the leading mines of California, Idaho, and Oregon; its shape being round, and made to resemble a Greek dome, the top or cover being supported by eight columns of solid gold quartz rock, beautifully polished, each capped with pure gold.

The cover forming the roof of the dome is exquisitely inlaid with quartz rock of variegated colors, filled with the precious metal, and is bound on edge with a solid rim of gold, the inside being lined with solid gold. The body of the box is made from one large mass of quartz rock, bored out and elegantly polished on the outside, while the inside is lined throughout with solid gold, and rests on an ornamented base made of quartz rock mounted in gold.

The whole is surmounted with the emblem of California, viz., the grizzly bear, who is represented as crossing the great overland railway.

The powder-puff is made of the same material, and is of the greatest taste. Two pounds of solid gold and the same quantity of gold quartz were required to make the above.

The third is the most rare and beautiful jewel casket in the world. This casket, representing the substantial wealth of the mines on the Pacific Coast, is made entirely of gold and gold quartz rock from the mines of California, Oregon, and Idaho, and required the steady work of five of the most skillful artisans for six months for its completion. It is about 15 inches long, 10 inches wide, and 12 inches deep. For richness of beauty and novelty it has never been surpassed, not even by the celebrated damascened casket of the sixteenth century, made at Venice by the artisans "Azzuminsti." It rests on four feet of solid gold, each of which represent the symbolic female figure that adorns the coat of arms of the State of California, with the bear by her side. The figures are in full relief and most elegantly formed, and constitute a salient feature of the beautiful work. The sides and ends of the casket are composed of solid slabs of gold quartz, highly polished, cut in spheroids, and are inlaid in solid gold with ornamental surroundings. The four handsomely wrought pillars are of Roman-Doric style, which is artistically carried out in the entire work. The base of the casket is ornamented with graceful foliations which are repeated upon the moldings that finish the lid or cover. The top is of solid gold beautifully inlaid with gold quartz in the finest mosaic work, hundreds of pieces being required for the construction of this exquisite cover.

The workmanship will bear the most exacting criticism, and the patient skill of the lapidist and the genius of the designer are freely shown here. It is as beautiful as a fresco and more like a painting than the work of the harder tools in jewelry.

The most elegant part of the whole casket is the exquisite piece of workmanship on the inside of the cover—it being a pictorial and historical representation of a buffalo hunt on the plains. The engraving of the landscape is very fine, the shrubbery and trees being in bas-relief. In the foreground is the railway track with two buffaloes dashing across it to evade the hunters who are in close pursuit. All of this is in alto-relievo and with great expression. The figures are not only correctly proportioned but skillfully handled, and the whole representation is artistically wrought; while the foreground is in high relief the background is in low relief, which decreases gradually in the distant perspective. The key is also inlaid with quartz.

The whole, weighing nearly nineteen pounds of solid gold and gold quartz, is valued, with the other articles, at 150,000 francs.

The case to contain the same is made of the different species of wood grown on the Pacific Coast.

The above description was written by a Paris connoisseur, in Paris, the world's art center, and was not disputed. No higher compliment could be paid to the San Francisco artist artisans that did the work or the jeweler who designed it. The exhibit was one that attracted universal attention.

Quartz sands, which are abundant all over the world, and especially so in California, are used for many purposes, as in mortar and cement, for grinding and polishing, cutting marble, glass making, etc. For the latter purpose the sand must be clean and free from impurities, except for the most ordinary qualities of ware.

GLASS.

Glass is an artificial silicate of soda or potash, to which other substances are added, all of them mineral, to produce varieties of quality, color, or appearance. The following are the most important: lead, bismuth, zinc, iron, manganese, copper, uranium, gold, tin, antimony, chromium, alumina, silver, cobalt, borax, strontia, baryta, fluorspar, and cryolite. The foundation of glass is silica, generally supplied in the form of quartz sand, but sometimes quartz rocks, flint, etc., are pulverized for that purpose.

The invention of glass antedates the earliest history. The discovery was probably the result of accident. Pliny relates the following account of its supposed origin, although it was probably known in prehistoric times: "In Syria, there is a region known as Phœnice, adjoining to Judæa, and inclosing between the lower ridges of Mount Carmelus a marshy district, known by the name of Cendebia. In this district it is supposed rises the river Belus, which, after a course of five miles, empties itself into the sea near the Colony of Ptolemais. The tide of the river is sluggish and the water unwholesome to drink, but held sacred for the observance of certain religious ceremonials. Full of slimy deposits and very deep, it is only at the reflux of the tide that the river discloses its sands, which, agitated by the waves, separate themselves from their impurities, and so become cleansed. It is generally thought that it is the acridity of the sea water that has this purgative effect upon the sand, and that without this action no use could be made of it. The shore upon which this sand is gathered is not more than half a mile in extent, and yet, for many ages, this was the only spot that afforded the material for making glass.

The story is that a ship laden with niter (alkali) being moored upon this spot, the merchants while preparing their repast upon the seashore, finding no stones at hand for supporting their caldrons, employed for the purpose some lumps of niter, which they had taken from the vessel. Upon its being subjected to the action of the fire in combination with the sand of the seashore, they beheld transparent streams flowing forth of a liquid hitherto unknown. This, it is said, was the origin of glass. Seutonius quotes Pliny to the effect that "the art of making glass malleable was actually discovered under the reign of Tiberius, and that the shop and tools of the artist were destroyed lest by the establishment of this invention gold and silver should lose their value. Dion adds that the author of the discovery was put to death."

Glass was manufactured in great abundance in the ancient cities of Rome, Carthage, Babylon, Tyre and Sidon, Memphis, and Thebes. In more modern times the manufacture was transferred to Constantinople and Venice.

White sands have been found in California. The tailings of some of our quartz mills are nearly pure silica; if not wholly free from metallic impurities they could probably be rendered so by careful washing. The more common varieties of glass are already manufactured in California, which will doubtless increase until the home demand is supplied. It has been difficult to obtain sand on the Pacific Coast for the finer manufacture of glass—that is, fully up to the requirements of the glassmaker. This difficulty will probably disappear when more careful trials are made of the beautiful white sands of the State, without the prejudice that seems to warp the judgment of workmen accustomed to the use of material from a particular locality, and who are inclined to attribute any fault in the product to the new.

GLASS MAKING IN CALIFORNIA.

Owing to the extent to which the business of preserving fruits, meats, and vegetables, the bottling of wine and mineral waters, and the manufacture of chemicals and patent medicines, is being carried on in California, the demand for bottles, vials, and various other glass vessels of the coarser kinds, has reached considerable proportions. To meet these requirements, two glass factories were originally founded in San Francisco, one, the Pacific Works, in 1862, and the other, the San Francisco, four years later, the two having since been united in one establishment bearing their conjoint names. At these works, located on King Street, near Fourth, are made glass wares of the several kinds above mentioned, also lamp chimneys and globes, retorts for use in chemical laboratories and acid works, carboys, etc. This company intend to engage shortly in the manufacture of goblets, druggists' material, flint glass, and other articles of the finer kinds, to which end they have projected an enlargement of their works, and brought from the East a number of artisans skilled in this branch of the business. With this addition perfected, the present working force, amounting to 150 hands, will be increased about one half. The money paid out here, on account of wages, amounts annually to nearly $100,000, which sum will hereafter be swollen to $150,000, at least. This company procure most of their sand from Antwerp, Belgium. It is said that the sand obtained from Monterey County does well enough for making ordinary wares, but does not answer for the finer kinds. Their supply of soda ash comes from England; of lime, from Cave Valley in this State. This company being desirous of obtaining a first-class sand nearer home, prospectors should keep an outlook for deposits of this description.

A company, mostly residents of Oakland, has lately been formed for the purpose of starting a window glass factory in that city, this being a distinct branch of glass making. In connection with the above business, this company will manufacture glass tiles by a patent process of which they are the owners. The proposed works are to be located on a four-acre lot at the foot of Linden Street, which, having a water frontage, constitutes an eligible site for the purpose. As to the time when these Oakland parties expect to commence active operations, we are not advised.

Silicified wood is a variety of quartz. The woody fiber is gradually replaced by quartz, leaving the form of the wood intact, so much so that sections cut and placed under the microscope show the characteristic grain of the wood, by which the genera may often be determined, and sometimes the species. Beautiful specimens of silicified wood are found in the hydraulic gold mines of the State. The petrified forest, in Sonoma County, is remarkable for the number of trunks lying on the surface of the ground. The beach at Pescadero, San Mateo County, has a wide celebrity for the beautiful pebbles found there. These are nearly all quartz, agates, carnelians, jaspers, and chalcedony, of many beautiful varieties. On the shore, under a low bluff, nearly at the sea level, a stratified sandstone dips from 65 to 72 degrees from the horizontal to the southwest. The strike is N. W. to S. E., magnetic. Upon this, unconformably, lies a sedimentary formation, more recent, in horizontal strata, consisting of sand, waterworn bowlders, and pebbles. This formation constitutes the bluff, and the pebbles on the beach result from its disintegration. The upper sedimentary seems to be formed from disintegration of the lower, which extends inland to an unknown distance. In the lower formation the sandstones are of different degrees of fineness, from the finest silt to very coarse conglomerate; in the conglomerate may be seen small bowlders of chalcedony, jasper, agate, and porphyry, which are the same as those found on the beach; but the latter are concentrated by long continued action of the waves, which have washed away the sand, disintegrated the sandstone bowlders, and gathered the harder pebbles together on the beach. Some of the sandstones are cemented by oxide of iron, and all the loose sands are highly ferruginous. On the way from Pescadero to the beach the road is cut through a formation not stratified, but in which the bowlders are imbedded. This general formation seems to be the same as is observed in the oil regions of San Mateo, Santa Clara, and Los Angeles Counties.

Some of the deposits of diatomaceous earths in the State are nearly pure silica. A deposit of a similar nature, at Staples' Ranch, San Joaquin County, but in which no diatoms have been found, gave the following results, by analysis made in the London Hospital:

Silica	94.64
Water	3.33
Alumina	.40
Sulphate of lime	1.63
	100.00

Quartz is very abundant in the State. The following localities produce the mineral in specially interesting forms:

Quartz crystals, doubly terminated, are found in Beveridge District, Inyo County; Modoc mine, Inyo County; Morning Star mine, Alpine County. Coated with malachite, at Panamint, Inyo County. On silver ore, Bodie, Mono County; No. 3782, fine crystals, same locality; No. 5163 is a long triangular prism, the edges modified by narrow planes, from the Standard mine, Bodie, same county. No. 13 is a large cluster of fine crystals, from the Wyoming mine, Panamint, Inyo County. Mariposa mine, Mariposa County; near Hornitos, fine, Mariposa County. No. 1451, Calaveras County. Fine crystals, Granite Basin, Plumas County (Edman). Red Hill, Placer County (Blake). Grass Valley, Nevada County, gold mines; often supporting gold between the crystals (Blake). Rock crystal, near Placerville, El Dorado County. No. 3706, rose quartz, massive, very fine, Hope Valley, Alpine County. No. 3707, rose quartz, Yokhe Valley, Tulare County. No. 3708, rose quartz, Plumas County. No. 4143, smoky crystals, Beveridge District, Inyo County. Smoky quartz crystal, six inches in diameter, found near Placerville, El Dorado County (Blake). No. 2446, smoky quartz, North Fork of Feather River, Butte County. Smoky (cairngorm), Summerfield, Mosquito Cañon, near Placerville, El Dorado County. No. 138, hacked quartz, with gold, Shasta County. No. 471, hacked quartz, Pine Tree mine, Mariposa County. No. 49, drusy quartz, Alpine County. No. 1446, quartz breccia, Hirchman's hydraulic mine, Nevada County. Hornstone, Mono County. Quartzite, Malakoff mine, Nevada County.

Agate.—San Luis Obispo County (Trask); Long Valley, Plumas County; in great variety at Spanish Creek, same county (Edman); Pescadero beach, San Mateo County.

Aventurine.—I have in my private collection a beautiful specimen of this variety of quartz, with section for the microscope; from an unknown California locality.

Bloodstone.—No. 4802 was found in gravel, near Windsor, Sonoma County. It is said also to be found in Jess Valley, Modoc County.

Carnelian.—Found on the beach above Crescent City, Del Norte County; Pescadero, San Mateo County; and on the shores of Lake Tahoe.

Cat's-eye.—Represented by a single specimen in the State Museum, No. 2265, from Calaveras County.

Chalcedony.—Nos. 2164 and 3721 are from Volcano, Amador County, where it occurs in many varieties; No. 1528 is from Pescadero beach, San Mateo County; Eclipse mine, Inyo County; Sonora trail, Alpine County; No. 546, from Murphy's, Calaveras County; No. 574, near St. Helena, Napa County; No. 962, Big Tank, Colorado Desert, San Diego County; No. 1206 (chalcedonic quartz), Vallecito, Calaveras County; No. 1397, Soledad Cañon, S. P. R. R., San Bernardino County; No. 1427, Douglassville, Tuolumne County; No. 1547 (chalcedonic bowlders), Bodie, Mono County; No. 2395, Sonoma County; No. 4349, with stibnite and cinnabar, Manhattan quicksilver mine, Napa County; No. 4283, Los Angeles County; beach at Crescent City, Del Norte County; hills back of Berkeley, Alameda County; large masses of white chalcedony, delicately veined, and mammillary sheets, occur in Monterey County, near the Panoches; in pear shaped nodules in the eruptive rocks between Williamson's Pass and Johnson's River, Los Angeles County (Blake).

Jasper.—No. 94 is from the Potrero, San Francisco, and has been mentioned before; found also at Claremont Hill, Plumas County; near St. Helena, Napa County; Tuolumne County; Crescent City, Del Norte County; Sausalito, Marin County; Mumford's Hill, Plumas County; (red) gold mines, Calaveras County, in the "Iron Hat" or croppings; (brown) Murphy's, Calaveras County (this stone polishes beautifully, and might be used for jewelry and ornamental purposes); (red) Monitor, Alpine County.

Quartz Sand.—No. 444, beach at Monterey, used for glass making in San Francisco; No. 4804, thirty-two feet below the surface at Lincoln, Placer County, with lignite in beds two to four feet thick; very pure quartz.

Silicified Wood.—No. 150, Portersville, Tulare County; No. 304, Columbia, Tuolumne County; No. 486, Eclipse mine, seven miles west of Lower Lake, Lake County; No. 1171, near Angel's Camp, Calaveras County; No. 1193, Gold Run, Placer County; No. 1251, Calaveras County; No. 1772, Dutch Flat, Placer County; No. 1855, near Roseville, Placer County; No. 2167, near Volcano, Amador County; No. 2387, Burnell Valley, Sonoma County; No. 1856, near Calistoga, Napa County; No. 2433, with lignite, Mount Diablo coal mine, Contra Costa County; No. 3423, Omega, Nevada County; No. 3444, Chalk Bluffs, Nevada County, in great variety; No. 3781, Duryea hydraulic mine, Chili Gulch, Calaveras County; No. 4113, San Luis Obispo County, twenty feet below the surface; Hirchman's hydraulic mine, near Nevada City, Nevada County; Mono Lake, Mono County; Santa Rosa, Sonoma County (wood before being silicified had been pierced by worms); Downieville, Sierra County; near Forest Hill, Placer County.

Quartzite—see Quartz.

122. QUICKSILVER. Etym. "*Living Silver.*" Mercury.

Mercury is one of the most beautiful and useful of metals, and the only one known to science which is fluid at ordinary temperatures. It is so volatile that it begins to vaporize at low temperatures—even when exposed to the sun's rays in Summer.

The vapors of mercury are, when strongly heated, highly expansive, and when confined, explosive, like steam, as Geoffroy discovered to his astonishment, when, at the suggestion of an alchemist, he placed some mercury in an iron globe, which he then put in the fire (with what motive history does not state). The result was a grand explosion, and the dissipation of the metal in invisible fumes.

Mercury does not become oxidized even when shaken in contact with oxygen gas. It has a strong affinity for sulphur, with which it combines when rubbed with it in a mortar. It is separated from its natural compounds by distillation with lime, iron scraps, carbonate of soda, or other reagents.

The atomic weight of mercury is 100.04 by the old system, which is doubled in the new. The symbol is (Hg.) from the Latin Hydrargysum, literally "silver water."

It has a specific gravity at 40° *above* zero of 13.545, while at 40° *below* it is 15.612. Until the year 1759 it was not known that it could be brought to the solid state. This fact was discovered by accident in making experiments with freezing mixtures. In the Winter of 1799 a mass of solid malleable mercury, weighing fifty-six pounds, was obtained. At Hudson's Bay very interesting experiments were made with congealed mercury. A mass was frozen and hammered on an anvil, of the same temperature, to a sheet as thin as paper. A piece of the mercury-foil was thrown into a glass of warm water, which was instantly turned into ice, while the mercury as quickly returned to its fluid state. So intense and energetic was the change that the glass was broken into fragments.

Mercury was well known to the ancients, who, however, seem to have had strange ideas regarding it. They thought it was silver in some peculiar allotropic state. The name "*Argentum Vivum,*" by which they knew it, lead to the modern name "Quicksilver."

Four centuries before Pliny's time this metal is mentioned by Aristotle and Theophrastes, under the name of "fluid silver." Vitruvius describes a method of fire gilding copper and silver by its aid, much as the same process is conducted at the present day.

The alchemists named this metal after the Greek mythological god Mercury, and represented it by the caduceus or winged rod of that deity intwined by two serpents, or a modification of that symbol. Corrosive sublimate was known to the Arabian chemists and calomel to the alchemists. Cinnabar has been used from time immemorial as a face paint by savages.

Pliny writes that the Greeks obtained vermilion from the Almaden mines in Spain 700 years before the birth of Christ. It was known as "Minium," a name now applied to oxide of lead. It was found as a scarlet sand in the beds of rivers. Ten thousand pounds were sent to Rome annually, under seal, where it was manufactured into vermilion.

The word vermilion is of quite recent origin, being taken from the French word "vermeil," from "vermiculum," a name applied in the Middle Ages to *Kermes*, which is the Arabic name for an insect from which a red dye was obtained. The literal translation of *Kermes* is "little worm," hence the name "vermiculum" and "vermilion."

Metacinnabarite, described elsewhere, is a new and rare mineral discovered in the Redington mine. It is the black sulphide of mercury, and bears the same relation to cinnabar that ethiops mineral does to vermilion.

Vermilion was extensively manufactured by the Dutch for many years, and their product was highly esteemed. The Chinese have long manufactured a fine article, which is well known, and is sent to this country in small paper parcels. It is now made extensively in

England and the Eastern States of excellent quality, and there is no reason why it might not be produced in California to a great profit, as may be said of all the salts and preparations of mercury.

In first working the vast sulphur bank near Clear Lake the greatest difficulty was the presence of mercury, which blackened the sulphur when attempts were made to refine it.

In some of the California quicksilver mines the heat is uncomfortably great, and the gases which are generated quite dangerous—so much so that powerful blowing machines are used to cause an artificial draft.

There can be no doubt that the agencies which have produced older deposits of mercury, are now in active operation here. At the Valley mine, in Pope Valley, a small stream passes very close to the old workings, and in the pools caused by slight impediments in the bed of the stream, the bubbling of the gases may be seen at any time. The locality has recently gained quite a celebrity as a mineral spring under the name Etna Springs.

MINERAL FORMS.

Most of the mercury of commerce is obtained from the sulphide (cinnabar). The other minerals containing it are only regarded as mineralogical curiosities. But as it may be interesting to know them, they are given below, with the percentage of mercury they contain:

Ammiolite (antimoniate of mercury), 19 to 24; Amalgam (silver 34.3), 65.2; Calomel (chloride of mercury), 84.9; Coccinite (iodine of mercury); Tiemanite or onofrite (selenide of mercury), 65 to 74.5

Mercury is found in California, native disseminated in serpentine rocks, and as *Cinnabar* (sulphide of mercury). This mineral is of a bright red color, the streak scarlet. H.=2. 2.5, sp. gr.=8.99; composition (Hg. S.).

Mercury	86.2
Sulphur	13.8
	100.0

When prepared artificially it is called *vermilion* (mentioned above), which is much used as a pigment. In a closed tube alone it gives a *black sublimate*; with carbonate of soda, *metallic globules;* when pure it wholly volatilizes. The same test is a proof of the purity of artificial vermilion, a test I am sorry to say it will seldom stand.

Mercury, when impure, is dull in luster. When shaken in a bottle a black powder separates; when retorted a residue remains behind. If a globule is allowed to run down a gentle incline, on white and dry writing paper, it leavs a *tail* behind it. To purify it, it must be *retorted.*

The method of separating gold from amalgam gathered in mining, is given under the head of gold. Mercury is purified in the same manner. A piece of clean writing paper is then folded like a filter, and fitted into a clean glass funnel. In the point of the filter a pinhole is made. The mercury will pass through the pin-hole in a thin stream, leaving any mechanical impurity on the filter. In some cases this operation may require to be repeated. If filtered into a perfectly clean bottle, the mercury will be pure.

Mercury has many uses in the arts. It has the property of combining with other metals forming *amalgams*. This property is taken advantage of in mining and metallurgy. The gold in California and elsewhere is chiefly collected by the agency of mercury. An amalgam of mercury and tin forms the backing of mirrors, and is really the reflecting surface. It is used also in the arts in gilding metals. It is used to fill thermometers and barometers, and for filling pendulums of large clocks. Mercury is used in pharmacy, as calomel, corrosive sublimate, mercurial ointment, etc.

Although mercury is so beautiful, and while in a metallic state so harmless, yet when oxidized and combined with other elements it is the most deadly of poisons. Although instances are on record of large quantities having been swallowed without great inconvenience, yet the action of its salts on the animal economy is something fearful to contemplate.

But in the hands of skillful physicians it is much used as a medicine, and in some cases is almost a necessity. It is a question who used it first in medicine, but it is generally admitted that it was either Rhazes, who died in 932, or Avicenna, who lived until the year 1037.

Corrosive Sublimate.—Bichloride of mercury has since the advent of the cholera in Europe been brought prominently before the world as a *germicide.* That is, a substance which has the property of destroying disease germs; in other words, a perfect disinfectant. It is considered by the best authorities the most powerful germicide known.

Mercury is used in the chemical laboratory and in many minor ways. Sodium amalgam is employed in certain metallurgical operations described in the second annual report. It is prepared as follows. It should be freshly made to be effective. If long kept it becomes oxidized and does not give satisfactory results, and the coal oil poured in the bottle by the manufacturing chemist is detrimental to the collection of the gold. For these reasons it is sometimes unjustly condemned. It should be prepared by the miner himself, in quantities to suit, and be immediately used. The preparation is simple and requires no skill. Metallic sodium may be kept in a convenient wide-mouth bottle, covered with naphtha or coal oil. It is best to keep it in large pieces, and to cut it into small cubes when required. All that will be required for a single clean-up can be made in a small frying pan. The details of the operation are as follows:

The pan must be perfectly clean and dry. A small quantity of mercury from a fresh flask, or at least not contaminated with mineral impurities, say five or six pounds, is poured into the pan, and dried, first with a sponge, and then by heating hotter than boiling water, but not so much so as to volatilize any of the mercury, which would be dangerous to the health of the operator. In the meantime, a piece of sodium is taken from the bottle and wiped with a perfectly dry rag. It is then cut into half-inch cubes. This is done with a common knife, the metal cutting like wax. The mercury is taken out into the open air. The operator places himself on the windward side of the pan, and lifting one of the small cubes of sodium with a long pair of cupel tongs, or pointed wire, places it in the center of the warm mercury. A flash will follow, and a small quantity of the mercury will be volatilized. Another cube is laid in the same place, and the same flash will follow, but it will be less intense. This is repeated three or four times, when the sodium will sink down quietly. At the proper moment it will be observed that there is a solid mass of amalgam in the center. It will then be perfectly safe to stir the contents of the pan, when a few more cubes added will change the whole to a mass of beautifully crystallized sodium amalgam, which may be put into closely stoppered glass bottles, in which it will keep for some time without coal oil or other protection, but when the bottle is opened the whole should be used, as it will soon, otherwise, decompose and spoil. The bottles in which it is kept should be selected to hold just what is required for use at one time.

It will be found every way advantageous to the miner to make his sodium amalgam according to these directions. The precautions to be observed are to avoid the fumes of mercury during the operation, and to be sure that everything used is perfectly dry.

ASSAY OF MERCURY.

The assay of mercury is simple when approximative results only are sought. It may be assumed, however, that these assays termed "approximative," in contradistinction to "accurate," are sufficiently correct for ordinary purposes.

The best practical test, especially for the prospector, is to use the horn spoon, and treat the pulverized rock as for gold. If the rock contains cinnabar an intensely red powder, fringing the residue, will be obtained for a "prospect." If in a metallic state, minute globules will be the result. After a few trials the prospector will feel the utmost confidence in his assays, and will decide at a glance whether his ore contains mercury, and approximately the quantity. The best vessel for this assay is the *batea*, described elsewhere. If there is a particle of cinnabar present, it will be found at the point of the prospect, clearly distinct from all other substances. The value of the *batea* to the prospector cannot be too highly estimated, and it should come into more general use.

The usual assay is based on the fact that all compounds of mercury are volatile, and may be sublimed by heat, and again condensed by cold, thus freeing them from non-volatile impurities. If the mercury is in the metallic state sublimation separates it all without addition. But when combined with other volatile substances, something must be added to retain the impurities and allow the mercury only to sublime.

In a great majority of cases the assayer will find his sample to contain mercury, if at all, in the form of the sulphide.

Either carbonate of soda or metallic iron will decompose cinnabar. If carbonate of soda is used, part of its oxygen combines with part of the sulphur, forming sulphurous acid, setting carbonic acid free while the balance of the sulphur combines with the sodium. The mercury thus set free sublimes over in a state of purity.

In the case where iron is used, the sulphur combines with the iron, setting the mercury free, as before.

In conducting this assay certain precautions should be carefully observed. If the ore is rich, from ten to twenty grams is sufficient for assay; if rather poor, from one to five pounds must be taken. If the ore shows slight indications only of mercury, a large quantity must be concentrated by washing, in the manner before described, and the concentrations only submitted to sublimation. To insure correct results and a perfect decomposition, the ore must be finely ground and intimately mixed with the reagent used.

The best apparatus in which to make this assay is the ordinary iron retort, with cover and screw clamp, in common use by miners, described under the head of retorting or purifying metallic mercury. A very convenient substitute may be improvised by cutting off a piece of common iron gas pipe, one inch inside diameter and about a foot long, fitting a cap to one end and a reducer to one fourth inch to the other. A bent one fourth inch pipe, of any convenient length, screws into the reducer. Any gasfitter will understand this description. To charge the apparatus it is only necessary to remove the cap and on replacing it see that the joint is tight. To insure this a little fire clay or wet wood ashes may be rubbed into the thread of the screw.

To charge the retort, the cover is removed, and the charge introduced; a little wood ashes, made into a stiff paste, is placed between the rim of the retort and the rabbet of the cover, which must then be tightly screwed down and the oozing lute rubbed off and the joint carefully examined before placing the retort in the fire.

The assay must be prepared as follows: Equal volumes of the ore and dry carbonate of soda are intimately mixed and placed in the retort; a layer of carbonate of soda is added and the whole settled down by tapping gently on the table; the assay should not more than two thirds fill the retort. After luting the cover as before described, it is ready for the fire, which may be made of charcoal or wood, or the retort may be placed in an assayer's furnace.

The open end of the bent tube must dip beneath the surface of water held in a convenient vessel, which may be of iron, porcelain, or even wood. If the pipe dips too deeply there is danger of explosion, should the water pass into the hot retort as it cools and thus forms a vacuum. When the operation is complete, and no more mercury comes over, the end of the tube may be raised from the water, and the apparatus allowed to cool. The bent tube should then be carefully unscrewed from the cover of the retort, and gently tapped to insure the removal of any globules of mercury which may have remained in it. If any are found they must be added to the collected mercury in the dish. Before the water is poured off, the surface must be carefully examined to see that no minute globules float upon it. These are sometimes so small that they can be seen only by a powerful magnifying glass. If the eye is placed nearly on a level with the surface, a metallic film will be seen if any of the metal floats, in which case it is only necessary to stir the water briskly, when the globules will sink and attach themselves to those beneath.

The water may then be carefully poured off, and the mercury, which is rarely found in a single globule, be washed into a small clean evaporating dish. The surplus water is then removed by means of pieces of blotting paper, or what is better, filtering paper. The dish must be again half filled with water and its contents boiled. After which the mercury must be again dried with blotting paper and placed in a watch-glass or porcelain cup and weighed.

Mercury is always calculated in percentage. Thus, if the ore weighed one hundred grams and the mercury one, then the ore contained one per cent of mercury.

A very ingenious method of assay of mercury has been contrived, which, however, has some disadvantages.

The weighed and pulverized ore is placed in a porcelain crucible, the edges of which are ground evenly. Half its weight of pure iron filings are mixed with it and covered with a thin layer of the same. A concave cover of pure gold is then placed over the crucible and the concavity filled with water. The crucible is then placed over a Bunsen gas burner, or alcohol lamp, and heated for ten minutes. The mercury sublimes and attaches itself to the gold. When the operation is complete, the cover is removed, washed carefully with alcohol, dried in a water bath, and weighed. It is then heated red hot, to dispel the mercury, and again weighed. The loss in weight indicates the mercury in the ore. No other metal than gold would give correct results, as that metal does not oxidize or lose weight when strongly heated.

A modification of this assay, which, in the hands of a skillful manipulator, gives very accurate results, may be made in a glass tube. The tube for this purpose should be of hard German glass, of about half an inch internal diameter, five or six inches long and closed at one end. The amount weighed out of the ore should vary from half a gram to one gram, according to the richness of the ore. The assay must be mixed on a clean piece of writing paper with carbonate of soda, which has recently been heated to redness to expel water. The soda should equal the assay in volume. To introduce it into the tube, a very narrow strip of writing paper should be prepared, which, between the thumb and finger, is easily formed into a trough. The mixture is placed in this trough, which is gently pushed down to the bottom of the tube while in a horizontal position. When the tube is again held vertically, the mixture will fall to the bottom of the tube, leaving the other portions clean. This precaution is necessary, as any particles adhering to the inside of the tube interfere with the assay. On removing the paper slip and finding the glass above the assay perfectly clean, the tube may again be placed horizontally and shaken down a little, so as to leave a space over the mixture to allow the gases and mercurial fumes to pass to the cooler portions of the tube when heated, without the violent bubbling which would otherwise occur. The end of the tube in which the assay has been placed is then gently heated over a smokeless flame, which may be that of an alcohol lamp or a Bunsen burner. Very soon moisture will be given off, even although the soda may have been dried as directed. This comes from the ore, which cannot be dried safely before mixing. This moisture must be slowly driven—by gradually heating the tube—to a position beyond that of its first condensation, and removed before the mercury begins to sublime, by introducing a slip of dry filtering paper made into a roll. As the heat is increased, fumes of mercury are seen to arise and form a cloud in the tube. These soon condense, and form globules inside of the position first occupied by the moisture. When this is seen to occur, the heat may be increased by urging the flame with a mouth blowpipe, until the closed end of the tube is more than red hot, and the soda is in a state of fusion, when the tube may be set aside and allowed to cool. It will be found by examining the sublimate of mercury that there is a clean portion of the tube between it and the fused assay. If a deep scratch with a triangular file be now made at this part of the tube, the end containing the assay may be broken off, leaving the mercury undisturbed in the other portion. Now, if the tube be placed vertically, one end resting in a clean watch-glass, the mercury may be washed down perfectly by the aid of a small washing bottle. It is then an easy matter to dry the globule so obtained with blotting paper, and to weigh it.

It is more accurate to introduce a piece of pure gold foil, the weight of which is known, and with a small clean piece of wood to push it about in the tube until it attracts every particle of mercury. The gold is then removed, washed in distilled water, in a clean capsule, dried by being laid on filtering paper, and lastly in the air. The assay is then weighed on a very delicate balance, and the weight of the gold deducted.

This method, if carefully conducted, is very delicate, and may be relied on. It will give results in ore which will yield no mercury in a retort, or rather which cannot be collected from a retort assay, and the whole operation is under the eye, as the most minute trace of sublimate can be seen through the tube. It will be necessary in some cases, when the ore is rich, to increase the quantity of carbonate of soda, or decrease the ore, should a red or black sublimate be obtained, instead of a metallic one.

The assayer may under certain circumstances desire to practice the wet assay. To do this, all the appliances of an analytical laboratory, and considerable skill in manipulating, are requisite.

The usual reduction agent is proto-chloride of tin. The mercury compound, if solid, must be digested with strong hydrochloric acid and carefully decanted. This process must be repeated until all the mercury is in solution. If the solution of proto-chloride of tin is not clear, it must be made so by adding a drop or two of hydrochloric acid. The clear solution must then be added to the mercury solution in slight excess; the whole boiled, but only for a moment, to prevent loss by volatilization. On cooling, the mercury is found in the form of a black precipitate. The supernatant liquid must then be removed with a syphon and the precipitate boiled with dilute hydrochloric acid, which causes the mercury to form globules. It is then well washed, first with very dilute hydrochloric acid and finally with distilled water and dried, first with bibulous paper and then under a bell glass, over sulphuric acid. After which it is weighed.

When it is necessary to estimate mercury in a solution containing nitric acid, this acid must be removed, which may be done by evaporation with hydrochloric acid. The addition of hydrochloric acid and evaporation must be continued until no more smell of chlorine can be detected. It is very difficult to obtain correct results in the presence of much nitric acid. It is best, in such a case, to verify the results by some other method.

METALLURGY.

The metallurgy of mercury is more simple than that of any other metal. What has been said of the assay by sublimation, applies also to the recovery of mercury from its ores in a large way, except that generally no reagent is added to decompose the sulphide of mercury.

In the great furnaces employed, the sulphur burns away. To explain the process more fully, it may be said that the sulphur, which is combined with the metal, oxidizes when subjected to great heat, and the sulphurous acid so formed passes off, leaving the mercurial vapor to condense in the capacious chambers.

THE IDRIA MINE, AUSTRIA.

The furnaces formerly in use here were of simple construction, but of great size. In a central chamber, the ore in large lumps was placed over a fireplace of such construction that an intense heat could be produced; the ore being piled loosely in large lumps to admit of the passage of air. The pulverent ore, of which there is always some produced at the mines, was placed in earthern vessels, open at the top. The fire was gradually increased like that of a brick-kiln, until everything volatile was driven off. The mercurial fumes, mixed with those of sulphur, and some steam, passed through a succession of high chambers, entering each at the top, and passing to the next through an opening at the bottom. Most of the mercury condensed in the first chamber, but in the other chambers some metal was found mixed with soot. The furnace was allowed to cool between the working of each charge, which occasioned loss of time. In some of the improved furnaces in use on this coast, the charging and discharging is continuous, which is regarded as a great improvement. The furnaces now used at Idria are the most improved modern structures, fully up to those of California.

AT ALMADEN, SPAIN,

The treatment is somewhat different. The fireplace and receiving chamber for the ore are at the end of the furnace. The partly condensed vapors pass through a multitude of jointed earthenware receivers called "aludels," which are exposed to the air. At a depression in the center of the furnace, the aludels are loosely put together, to allow of the escape of condensed mercury, which is conveyed by channels to a central receiver, while the fumes pass on to a large chamber, in which final condensation takes place. This description can scarcely be understood without a drawing.

At the New Almaden, in California, the first furnaces were constructed on the same general principle of those at Idria. It is stated in a history of that mine that a "new process of smelting the ore was discovered by a blacksmith named Baker, which succeeded after $387,800 had been expended in experiments."

WASTE OF MERCURY.

A moment's thought will convince the intelligent reader that if there was no mechanical loss, the same mercury could be used over and over again, until the end of time, but it is well known that this loss is enormous. In all the cañons leading down from the Comstock mines, the ground is permeated with quicksilver, which has been lost, not to say thrown away, in working the ores.

If a specimen of the ordinary milling ore from the Comstock mine be examined microscopically, it will be found to consist of certain silver minerals dispersed through a large quantity of quartz. The proportion of quartz, or silica, in two samples analyzed by Mr. Arnold Hague, was respectively 84 and 91 per cent. By the present process, this large proportion of worthless matter must be saturated—so to speak—with mercury, to extract the silver from the small silver-bearing portion. Experiments have fully shown that owing to the greater specific gravity of the sulphurets, they may cheaply be separated from the quartz. Would metallurgists substitute a proper treatment, based on this general idea, and amalgamate the concentrations only, the saving in mercury would be very great.

PRODUCTION OF MINES OF CALIFORNIA—IN FLASKS.

The columns for the individual California mines (New Almaden, New Idria, Redington, Sulphur Bank, Guadalupe, Great Western, Napa Con., Pope Valley, Great Eastern, St. John, Altoona, Oakland, California, Sunderland, Abbott, Manhattan, Buckeye, Mt. Jackson, Bella Union, American, Porter, Wall Street, Rattlesnake, Kentuck) are illegible in this scan, except for a few figures:

Mine	Total
Great Eastern	10,2[illegible]
Sunderland	2,777
Manhattan	1,415
Buckeye	873
Mt. Jackson	597
[illegible]	300
Bella Union	271
Kentuck	51

Manhattan: Yearly production previous to 1876 not obtainable; estimated at 3,594 flasks, included in production of Various Mines.

Year	Various Mines	Total Yearly Production of California Mines	Exports from San Francisco by Sea and Rail—By Flasks	Price in San Francisco per Flask: Highest	Price in San Francisco per Flask: Lowest	Production of the Idria Mine, Austria—By Flasks	Production of the Almaden Mine, Spain, in periods of five years—By Flasks	Price in London per Flask: Highest	Price in London per Flask: Lowest
1850	......	7,723	6,467	$114 75	$84 1[illegible]	4,100	......	£15	£13 2s. 6d.
1851	......	27,779	10,791	76 50	57 75	4,092	......	13 15s.	12 5
1852	4,099	20,000	21,458	61 20	55 45	4,085	101,517	11 10	9 7 6
1853	......	22,284	18,800	55 45	55 45	4,409	......	8 15	8 2 6
1854	......	30,004	20,963	55 45	55 45	4,060	......	7 15	7 5
1855	[illegible]	33,000	27,165	55 45	51 65	4,446	......	6 17 6d.	6 10
1856	2,862	30,000	23,740	51 65	51 65	5,935	......	6 10	6 10
1857	......	28,204	27,262	51 55	45 90	9,189	110,0[illegible]	6 10	6 10
1858	[illegible]	31,000	24,112	49 75	45 90	1,977	......	7 10	7 5
1859	11,700	13,000	3,399	76 50	49 75	8,239	......	7 5	7
1860	2,939	10,000	9,488	57 75	49 75	4,821	......	7	7
1861	571	35,000	35,995	49 75	34 45	6,493	......	7	7
1862	1,885	42,000	33,747	38 25	34 45	4,712	122,117	7	7
1863	6,876	40,531	26,014	45 90	38 25	5,878	......	7	7
1864	2,286	47,489	36,927	45 90	45 90	7,263	......	9	7 10
1865	2,261	53,000	42,469	45 90	45 90	4,908	......	8	7 17 6
1866	2,621	46,550	30,287	57 35	45 90	5,327	......	8	6 17 6
1867	5,184	47,000	28,853	45 90	45 90	7,542	[illegible],224	7	6 16
1868	112	47,728	14,406	45 90	45 90	8,253	......	6 17	6 16
1869	......	33,811	24,11[illegible]	45 90	45 90	9,179	......	6 17	6 16
1870	......	30,077	14,240	68 85	45 90	10,715	......	10	6 16
1871	840	31,686	16,349	68 85	57 35	10,904	......	12	9
1872	......	31,621	16,780	66 95	68 00	11,116	16[illegible],608	1[illegible]	10
1873	3,276	27,642	11,164	91 80	68 85	10,[illegible]	......	20	12 10
1874	......	27,756	11,750	118 [illegible]	91 80	10,789	......	26	19
1875	1,501	50,250	37,829	118 [illegible]	49 75	10,717	......	24	9 17 [illegible]
1876	1,161	75,074	40,016	[illegible]	34 45	10,791	......	12	7 17 6
1877	250	79,396	72,095	44 00	30 60	11,020	208,200	9 10	7 2 [illegible]
1878	......	63,880	41,877	[illegible] 95	29 8[illegible]	10,40[illegible]	......	7 5	6 7 [illegible]
1879	81	73,684	62,815	[illegible] 45	2[illegible] 25	11,151	......	8 15	5 17 6
1880	......	59,926	46,294	31 45	27 5[illegible]	12,[illegible]	11,640	7 15	6 7 6
1881	376	60,851	45,790	31 75	27 90	11,[illegible]	[illegible]	7	6 2 6
1882	241	52,732	10,417	29 10	27 [illegible]	11,[illegible]	1[illegible],11[illegible]	6 5	5 15
1883	101	46,725	37,867	28 [illegible]	26 00	1[illegible]	46,[illegible]	[illegible] 17 6	5 5
Total	60,119	1,157,403	982,100	$118 [illegible]	$25 2[illegible]	275,982	1,045,451	£26	£5 5s.

Production in California for [illegible] years .... 1,357,403 flasks, each of 76.50 pounds avoirdupois.

Production in Austria for thirty-four years ...... 275,982 }
Production in Spain for thirty-four years ...... 1,045,451 } flasks, each of 75 pounds Spanish=34 507 kilograms=76 07 pounds avoirdupois.
———— 1,321,133

Italy and other countries, present yearly production estimated ...... 2,000 flasks.

[illegible] California, March, 1884.

LOCALITIES.

Mercury is found in but few localities in the world. The mines of Almaden in Spain, and the Idria in Austria, supply nearly all the mercury in the eastern hemisphere. The former are the most extensive and important in the world. The average richness of all the ore extracted is fully ten per cent. Immense beds or deposits of cinnabar are found at times from forty to fifty feet in thickness. The yield of 1850 was 2,500,000 pounds of metal.

The Idria mines, like the Almaden, have been worked for hundreds of years, and still produce large quantities of mercury. From 1843 to 1847, the average annual yield was 358,281 pounds. The yield of both the Idria and Almaden mines from 1850 to date are given in the table of Mr. J. B. Randol attached to this report.

The quicksilver mines of Peru were in former years of great importance. They were known to the inhabitants long before the invasion of the Europeans, although historians state that they used the red pulverulent cinnabar as a paint, but did not know the method of extracting the metal from it. Although as in California, traces of mercury are found widespread in Peru, the only mines of great importance are found in the Province of Huancavelica, the mine of Santa Barbara, known as the "Great Mine," being the most extensive and prolific. It has been worked since the year 1566. About the year 1576 the method of extracting silver and gold by amalgamation was discovered, which increased the demand for mercury and enhanced its price. To supply this demand, the Santa Barbara mine was worked to its utmost extent, much as the mines of mercury are at the present day, and for exactly the same reason. Between the years 1598 and 1684, the production reached its extreme, after which it gradually declined. The mines were controlled by the Spanish Government, which, knowing that silver could not be produced without its use, sold it to the miners in such quantities as it chose, and claimed a tax on silver in proportion, holding it as a check on the amount of silver which ought to be produced. About the year 1790, the Santa Barbara mine was ruined by the Superintendent, in his eagerness to produce the greatest possible amount of mercury, taking out the supporting pillars, which caused the roof to fall in and choke the mine. This accident proved to be a great calamity, and for some time materially checked the production of the precious metals. For many years these mines have remained unworked.

DEPOSITS IN CALIFORNIA.

Mercury was known to exist in California long before gold was discovered. As long ago as 1845 a company was formed to work the New Almaden mine.

There are some peculiarities about the quicksilver mines of California that are worthy of attention. It is generally admitted, as stated before, that the agencies are now at work in these mines by which other fissures have in ages past been filled with the various metals.

The daily and yearly production of cinnabar, sulphur, metallic mercury, and even gold and silver, may be studied as the labor of a colony of bees can be watched in a hive. Mr. Attwood, of this city, who has given the subject much thought and study, says: "Cinnabar deposits are plutonic and occur in volcanic fissures filled by the condensation of metallic vapors which find their way from below, and condense on the sides of such fissures; also, in the looser portions of the adjacent rocks which have been softened and rendered porous by the heated vapors."

Dr. Oxland, formerly manager of the Borax Lake Company's works, has published some very interesting notes on the same subject. The sulphur bank, since proved to be a valuable quicksilver deposit, was carefully studied by him. He found this deposit to be constantly forming with evolution of carbonic acid, aqueous vapors, and boracic acid. The temperature of the vapors was 95° F., and he found them to be the agencies which brought gold, silver, iron, and mercury to the surface and deposited them on the sides of the fissures and seams in which gelatinous silica also forms, becoming indurated in time to opal. There is also a tarry hydrocarbon found pervading the silica, in which case metallic mercury was shown to replace the cinnabar. There is a striking similarity between some of these veins and the Mexican mine at Virginia City; so much so as to lead to the assumption that the Comstock ledge is the result of similar action.

It is unfortunate for the army of quicksilver prospectors, that *indications* of cinnabar are encountered in almost every part of the Coast Range. If to find cinnabar was in every case to discover a quicksilver mine, that metal would soon be a drug in the market. Prospectors are, therefore, cautioned not to let their hopes eclipse their discretion. The mines which have produced quicksilver in California and the quantity from each, are shown by the tables of Mr. Randol.

HISTORY AND CONDITION OF THE INDUSTRY IN CALIFORNIA.

Cinnabar Deposits.—There are in this State many deposits of cinnabar that, with the price of quicksilver doubled, could be worked with profit; the counties most distinguished for their wealth of cinnabar being Santa Clara, Fresno, San Luis Obispo, Trinity, Napa, Sonoma, and Lake, all containing mines that have heretofore been more or less worked, and in some of which mines are still being actively operated. Many of the deposits in these counties are characterized by certain peculiar features; thus, the New Almaden, the principal mine in Santa Clara County, is remarkable for its ore-producing capacity and the large production it has made; this being not only the first mine opened up, but also by far the most prolific in the State. The Altoona, the only mine in Trinity County, is noted for yielding an exceptionally high grade ore, while Napa, Sonoma, and Lake Counties, are conspicuous for extent of mineral territory and the great number of ore-bearing deposits, large and small, found within their limits.

Present Status of the Business.—This branch of mining in California is, and for the past seven or eight years has been languishing under low prices and diminished consumption, and this, notwithstanding the output of these mines has meantime been largely reduced. Some eight or nine years ago, when this metal was selling at from $1 40 to $1 50 per pound, these high prices led to such an over production as caused them to speedily decline, the wholesale price for the last eight years having averaged hardly more than forty-seven cents per pound. During this period of high prices a great many new mines were opened, and some of them equipped with reduction works, the most of these being located in Napa, Sonoma, Lake, and San Luis Obispo Counties. The drop in prices has led to a suspension of work on nearly all of these properties; the only quicksilver mines in the State that are now making any considerable production being the New Almaden, New Idria, Napa Con., Great Western, and the Redington, and these are all being run on a very small profit margin, so small that some companies are considering the policy of curtailing operations or suspending them altogether, being averse to wearing out their plant and to the further exhaustion of their ore stocks without any adequate return. The Sulphur Bank mine, formerly an active producer, was, for the reasons above mentioned, closed in 1883, and has since remained idle. How great the falling off in the product of the State has been during the past few years is shown by Mr. Randol's table.

The impetus so given to quicksilver mining in California, beginning in 1873, culminated three years latter, at which time more than thirty mines were making a greater or less production in different parts of the State, besides a great many locations that were being prospected, mostly in a small way. All of these producing mines were equipped with some sort of reduction works, and generally also with hoisting gear, the former consisting in some cases of mere retorts, or small furnaces, though a much greater number were outfitted with several furnaces of the best models and of large capacity. Operations have not only been suspended on nearly all of these mines, but, with the present outlook of the quicksilver market, they may be considered practically abandoned. The losses incurred by reason of these hasty and otherwise ill-advised movements were very heavy, having amounted, labor and money included, to millions of dollars. Scarcely ever in the history of this industry has the price of quicksilver been so low as it is now, nor have extreme low rates ever before held for so long a time as during the present era of depression. The lessened consumption of quicksilver, above alluded to, has grown out of diminished requirements for the mines on this coast, more especially those on the Comstock Lode. With a view to improving prices efforts were, from time to time, made to induce mine owners to take some concerted action looking to a restricted production, but as yet without avail, parties concerned being unable to agree upon a plan of procedure satisfactory to all.

Although the business of quicksilver mining was commenced in this State by the New Almaden company as early as 1846, not until 1850 was much metal turned out. Since that time the business has gone on with scarcely any interruption, the large quantity of 1,432,787 flasks, each containing 76.5 pounds avoirdupois, having been produced to date.

Mr. Randol's table shows the annual and total amount of quicksilver made in this State for the past thirty-five years, and of the first four months of the present year. It also gives the production of the Idria mine in Austria, and the Almaden in Spain, with prices in London highest and lowest for each year. It has been carefully corrected by Mr. Randol for this report, and is probably the most complete and reliable table ever published.

Exports.—Of the quicksilver produced in California, about twenty-five per cent is consumed on this coast, the balance being exported to the Eastern States and foreign countries. Of last year's production, 38,165 flasks, valued at $1,037,989, were so disposed of, 16,330 flasks having been shipped to China, 10,584 to Mexico, and 8,018 to

New York, with a little also to South and to Central America, Australia, Japan, British Columbia, etc. Formerly Great Britain took a good deal of our quicksilver, but since 1868 we have sent hardly any to that country, which of late years has obtained its supply chiefly from the Almaden mine, controlled by the Spanish Government. The largest exportations in any one year amounted to 62,845 flasks, made in 1879. The low duty on quicksilver—only ten per cent *ad valorem*—admits of the foreign article being largely imported into this country, the receipts from London having amounted in 1882 to 13,116 flasks, which quantity was considerably increased the following year.

Capital Invested, Labor Employed, Wages Paid, etc. — The capital invested in the live mines of California amounts at the lowest calculation to $3,000,000, this being aside from the large sums lost through unfortunate ventures and depreciation in the value of this species of property. The number of men employed in and about the quicksilver mines and furnaces in this State is, at the present time, something over one thousand, besides half as many more wood choppers, teamsters, timber cutters, etc., working on wages or contract, nearly one half of the entire number being in the service of the New Almaden Company. In the matter of nationality, these employés rank as follows: Mexicans, Chilenos, Cornishmen, Swedes, Americans, the latter being mostly engaged in teaming, wood chopping, etc. The day's work here is generally limited to ten hours, furnacemen working twelve-hour shifts. Miners usually receive $2 50 to $3 and surfacemen $2 per day, all boarding themselves where these rates are paid. Furnacemen are paid $2 50 per day, mechanics and foremen, $3 to $4. Where the men are boarded, a reasonable deduction is made from these prices, single men paying seventy-five cents per day for board, and about $5 per month for lodging. Men with families are furnished by the company with dwellings, for which they are charged a moderate rent, about $4 monthly.

NOT A PROFITABLE BUSINESS—NEED OF FURTHER PROTECTION.

As the value of the quicksilver produced in California approximates closely $50,000,000, this business has, of course, been of great public benefit, by reason of the large amount of labor it has employed and the subsistence it has afforded other industries. But, at the same time, this business has not, as a whole, proved very profitable to those engaged in it. So far as known the only quicksilver mines in the State that have ever paid much more than expenses are the New Almaden, New Idria, Redington, Napa Consolidated, and Great Western. All of these mines have one time or another paid dividends, and some of them in large amounts, the Redington a total of more than a million dollars, but only two or three of them have been making any net earnings of late, nor are they likely to make any hereafter unless a heavier duty shall be placed on the imported article. In the absence of such relief it may even happen that nearly all of the now producing mines in this State will, before long, be forced to close down.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FOR THE YEARS 1883 AND FIRST FOUR MONTHS OF 1884.

Furnished by J. B. Randol.

	Ætna.	Napa.	Great Western.	Sulphur Bank.	Reding-ton.	Great Eastern.	New Idria.	Guada-lupe.	Various.	Total (flasks).	New Almaden.	Grand Total (flasks).	Price in San Francisco (per flask).	
													Highest.	Lowest.
January	--------	590	390	280	367	262	112	77	7	2,085	2,497	4,582	$26 75	$26 00
	329	135	373	263	127	28	103	--------	7	1,365	1,440	2,805	26 25	26 00
February	--------	295	364	310	181	156	133	7	4	1,450	2,150	3,600	27 25	26 00
	276	174	241	--------	104	9	59	--------	--------	863	1,458	2,321	29 00	26 00
March	--------	485	305	335	202	162	142	--------	14	1,645	2,230	3,875	28 00	26 75
	249	152	223	68	123	2	36	--------	--------	853	1,606	2,459	29 00	28 00
April	--------	530	294	310	243	142	76	--------	3	1,598	1,756	3,354	27 00	26 75
	422	69	232	76	50	--------	75	--------	--------	924	1,785	2,709	29 00	28 00
May	--------	325	293	350	135	164	144	--------	13	1,424	2,344	3,768	27 00	26 75
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
June	--------	360	400	91	165	184	137	--------	10	1,347	2,214	3,561	28 50	26 75
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
July	--------	452	446	130	141	150	85	--------	2	1,406	2,618	4,024	28 50	27 50
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
August	--------	695	315	112	94	76	139	--------	--------	1,431	3,000	4,431	27 50	26 25
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
September	--------	750	297	265	45	81	164	--------	30	1,632	3,010	4,642	26 75	26 25
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
October	--------	521	215	206	109	134	272	--------	--------	1,457	2,672	4,129	26 50	26 50
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
November	--------	613	208	160	78	102	115	--------	--------	1,276	2,212	3,488	26 50	26 00
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
December	--------	274	342	63	134	56	87	--------	18	974	2,297	3,271	26 25	26 00
	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

NOTE.—The upper figures are for the year 1883, the lower for 1884, to May 1.

TABLE FOR CHANGING THE PRICE OF QUICKSILVER IN FLASKS TO AVOIRDUPOIS POUNDS—J. B. RANDOL.

New Almaden quicksilver, "A" brand, in flasks containing 76½ pounds avoirdupois.*

Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.
$26 00	33.98^7	$29 00	37.91^1	$32 00	41.83^5	$35 00	45.75^9
26 25	34.31^4	29 25	38.23^8	32 25	42.16^2	35 25	46.07^8
26 50	34.64^1	29 50	38.56^5	32 50	42.48^9	35 50	46.40^5
26 75	34.96^8	29 75	38.89^2	32 75	42.81^6	35 75	46.73^2
27 00	35.29^5	30 00	39.21^9	33 00	43.14^3	36 00	47.05^9
27 25	35.62^2	30 25	39.54^6	33 25	43.47^0	36 25	47.38^6
27 50	35.95^0	30 50	39.87^3	33 50	43.79^7	36 50	47.71^3
27 75	36.27^6	30 75	40.20^0	33 75	44.12^4	36 75	48.04^0
28 00	36.60^3	31 00	40.52^7	34 00	44.45^1	37 00	48.36^6
28 25	36.93^0	31 25	40.85^4	34 25	44.77^8	37 25	48.69^3
28 50	37.25^7	31 50	41.18^1	34 50	45.10^5	37 50	49.02^0
28 75	37.58^4	31 75	41.50^8	34 75	45.43^2	37 75	49.34^7

* Spanish and Austrian quicksilver flasks contain 75 pounds Spanish, equal to only 76.03 pounds avoirdupois.

ANNUAL EXPORTS OF QUICKSILVER FROM SAN FRANCISCO BY SEA FOR TWENTY-FOUR YEARS.

Years.	New York.	Great Britain.	China and Hongkong.	Japan.	Mexico.	Chili.	Peru.	Central America.	Australia, etc.	Panama.	British Columbia.	Miscellaneous.	Total Flasks.
1860	400		2,715		3,886	1,040	750		100	130	326		9,347
1861	600	2,500	13,788	50	12,061	2,058	2,804	110	1,850	57	116		35,994
1862	2,265	1,500	8,725	25	14,778	1,746	3,439	40	800	424	5		33,747
1863	95	1,063	8,889		11,590	500	3,376	40	300	120	42		26,015
1864	1,495	1,609	18,908	262	7,483	2,674	4,300	30	100	45	21		36,927
1865	6,800	10,400	14,248	500	2,789	2,000	5,500	8	200		24		42,469
1866	3,800	4,000	10,252		9,561	500	2,500	81	575	10	6	2	31,287
1867	2,900	1,500	9,811	200	10,043	800	3,000	30	550		20		28,854
1868	4,500	4,000	16,785		14,121		2,500	1	1,580		20		43,507
1869	1,500		11,600	30	8,010	1,400	1,500	20	300	1	4		24,365
1870	1,000		4,050	40	7,088		1,300		300	1	9		13,788
1871	800		7,900	2	3,081	850	1,300		1,206	60	6		15,205
1872	1,202		4,810		5,038	200	1,000	13	733	100	2		13,098
1873			1,600	44	3,454	26	335	32	105	147	9		5,752
1874	315		1,200	248	4,104	200	500	21	100	80	2		6,770
1875	287	100	18,190	968	5,757	400	2,000	34	1,090	104	17	13	28,960
1876	3,094	650	24,526	427	7,400	825	2,700	205	1,213	64	36		41,140
1877	818		31,195	377	8,088	575	2,969	77	1,820		16	51	45,986
1878	200		20,525	705	8,598	200	1,200	98	596		25	5	32,152
1879	500		36,958	777	10,774	650	1,612	105	1,051		10	1	52,438
1880	600		19,488	206	11,456	550	640	140	1,509	80	14		34,683
1881	400		17,006	325	15,141	150	660	58	1,359	151	14		35,264
1882	1,100		19,451	620	9,738	500	1,480	65	1,795		21	1	34,771
1883	3,100		16,365	1,218	10,764	170	800	59	760		11		33,247
Totals	37,771	27,322	338,985	7,024	204,803	18,014	48,165	1,267	19,992	1,574	776	73	705,766

The above statement includes only the shipments by sea. There was no other way of getting the article out of the State prior to 1869. In 1870, shipments began to be made to New York by rail, both from this city and San José. The quantity reported by rail does not include consignments to silver mines in Nevada. Shipments to the Nevada mines before the opening of the railroad were credited to the consumption of California, as there was then no record of such inter-State commerce, any more than there is now. The shipments of quicksilver out of the State by rail from San Francisco and San José, from 1870 to 1883, have been as follows:

Years.	Flasks.	Years.	Flasks.
1870	453	1880	11,646
1871	1,135	1881	10,534
1872	3,651	1882	5,702
1873	4,805	1883	4,640
1874	4,980		
1875	8,892	Total by rail, 14 years	89,246
1876	7,906	By water, 24 years	705,766
1877	6,338		
1878	7,596	By land and water, 24 years	795,012
1879	10,668		

The importance of this trade to California is best shown by the value of the article, which has varied, as before remarked, from $1 55 to 33 cents per pound. Both are extreme figures, and one is as unsatisfactory to the consumers as the other is to producers. One or two companies can probably make something producing the article at a price as low as 33 cents, but that depends, of course, on the existence of especially favorable conditions. The fact that nearly all of the thirty odd claims of this character in the State have been abandoned of late, with prices rating from 33 cents to 36 cents, shows what producers think of the matter, and it is the best evidence that there is no money in the business to them at such prices. At present the article is quoted at $29 per flask, which is equivalent to 37.91 cents per pound. But there is no talk of reopening mines on any such basis, though if 38 cents could be guaranteed right along, some mines would be reopened.

123. REALGAR. Name used by the alchemists. Sulphide of Arsenic.

Color bright red to orange yellow. H.=1.5—2., sp. gr.=3.4—3.6. Wholly volatile B. B. on ch. giving fumes of sulphur and arsenic, burning at the same time with a blue flame. Composition (As S).

Sulphur	29.9
Arsenic	70.1
	100.0

This mineral is rare in California, being known only with arsenolite in Alpine County, but it is very abundant in Washington Territory, east of Seattle, exact locality not given. This deposit is probably the one referred to in "Cleaveland's Elementary Treatise on Mineralogy and Geology," published in 1818, fol. 555, as follows: "On the northwest coast of America, it (orpiment) is mixed with realgar."

Red Oxide of Copper—see Cuprite.

Red Oxide of Iron—see Hematite.

124. RESIN. Fossil.

In the hydraulic gold mines of California a fossil resin is frequently met with, which is probably from the coniferous trees of former growth, found in such profusion in a silicified state. It is brittle and resinous, and still retains an odor. It somewhat resembles gum dammar, but is more yellow. It has never been studied. Represented in the State Museum by No. 4062.

RETINALITE—see Serpentine.

125. RHODONITE. Silicate of Manganese.

Named from its red color, from a Greek word, "the rose." It occurs in several localities in the State, always with pyrolusite; with native copper, Mumford's Hill, Plumas County (Edman); one mile from the Southern Pacific Railroad, between Colton and San Diego; near San José, Santa Clara County; two miles south of Summersville, Tuolumne County, in considerable quantity, No. 3657, State Museum. No. 4088 is from a large deposit of rhodonite and pyrolusite, two miles north of Sonora, Tuolumne County. Rhodonite has little or no economic value.

126. ROCK SOAP.

This is a mineral resembling halloysite and mordenite, but believed to be a mechanical mixture of two or more minerals. It has the remarkable property of removing impurity from the skin, like soap, whence the name. There have been numerous analyses made which do not agree among themselves. A paper was published by Prof. George H. Koenig, in *The Naturalists' Leisure Hours*, Philadelphia, which is very full and explicit, giving the result of considerable laboratory work. A series of analyses were made in the laboratory of the State University, which have not been published. In Prof. Koenig's examination the soapy portion was separated mechanically from a sandy portion and analyzed, with the following results:

Sesquioxides of alumina and iron	14.10
Silica	73.10
Water	6.70
Not determined	6.10
	100.00

Nearly all the silica was found to be in the soluble or opaline state, and the alumina either as a hydrate, or a very basic hydrated silicate. At one time this material was manufactured into a variety of useful articles, as salt water soap (it having been found that the presence of salt and lime did not impair its detergent properties), scrubbing, and toilet soap, and even tooth powder. Having had occasion to examine into the merits of these preparations, I am prepared to say that they served every purpose claimed for them. At the Paris Exposition of 1878 samples were shown which attracted considerable attention, and there were those who expressed an inclination to enter into their manufacture in France. At present "rock soap" is largely used in the manufacture of certain kinds of soap in California. No. 4024, in the State Museum, is a specimen from Ventura County, and No. 4794 is from San Benito County.

127. ROSCOELITE.

This very rare mineral was described in the second annual report, folio 262, and a history given of its discovery, but, as many who receive this report will not be able to refer to the former, I have thought best to insert the whole paper here:

Roscoelite is a new and extremely rare mineral found in El Dorado County, California.

Attention was first called to it by the reading of a paper by Dr. James Blake, at a meeting of the San Francisco Microscopical Society, July 2, 1874. The specimens then exhibited were from a mine or claim, known as the "Stuckslager," "Plum Tree," or "Sam Simms" mine, which lies in Section 24, Township 11 north, and Range 9 east, Mount Diablo base and meridian; somewhat more than a mile from the town of Coloma, in a southwest direction.

At a meeting of the California Academy of Sciences, held on July 20, 1874, Dr. Blake presented specimens of the same mineral, which he then supposed to be a chromium mica, having, in a preliminary examination, found, as he supposed, chromic acid combined with silica, potash, and lithium. Gold was also associated with the mineral in considerable quantities. He stated that it was found at Granite Creek, near Coloma, El Dorado County, remarking at the same time that the associated minerals were an interesting and beautiful microscopic study, and that the formation indicated that the gold must have been deposited between the flakes of the mica from an aqueous solution. He gave the new mineral the provisional name of "*Colomite*," from the locality.

The next notice appears in the proceedings of the California Academy of Sciences, Vol. 6, 1875, folio 150. At a meeting held August second of that year, Dr. Blake read a paper on "*Roscoelite*," a new mineral, in which he admitted that he had stated at a former meeting that the mineral contained a large quantity of chromic acid, an opinion derived from the results of superficial blowpipe tests. He had since sent samples to Dr. Genth, of Philadelphia, who found it to contain vanadium. He had given the name *Roscoelite* as a compliment to Prof. Roscoe, of Manchester, England, who has made vanadium a special study. In a foot-note, Dr. Blake expresses the opinion that vanadium may occur in these rocks in larger quantities than is generally supposed; and calls attention to the fact that Dr. Hall has found it widely diffused in many rocks.

The vein from which the roscoelite was taken is small and not continuous, varying from two inches to a foot in thickness, running nearly parallel with Granite Creek.

The quartz is ferruginous in appearance, and is associated with calcite and slaty matter, and at least two varieties of pyrites. Gold occurs only with the roscoelite, and usually in parts of the vein where the quartz disappears or "pinches out," as the miners express it.

Roscoelite was for a long time a mystery to the miners, and was first mistaken for plumbago. The pioneer placer miners at Big Red Ravine used to complain of the difficulty of saving the gold, owing to the interference of the "black stuff," as they designated it. In all probability, a large quantity of gold was allowed to escape from ignorance of the nature of this mineral.

Gold is found interstratified with laminæ of roscoelite, or imbedded in it, in pieces from the value of one dollar to the minutest microscopic particles.

The method of operation at the mine has been to remove superficial slaty covering by ground sluicing, and carefully working the small but exceedingly rich material found in the pay-seam. From one pan of this, 40 ounces of gold has been taken; from another, gold to the value of $100 was obtained. The fineness of the gold is .846.

Under the microscope, roscoelite is seen to be in scales and radiated tufts, the luster of which is silvery or pearly to a high degree—almost metallic by strong reflected light; color, light steel gray, yellowish dark green, or nearly black, as seen in different lights. Small deeply striated crystals of white iron pyrites are sometimes seen on freshly broken surfaces of quartz, partly imbedded. The quartz in actual contact with roscoelite is generally transparent and nearly colorless; sometimes rose-colored or amethystine. Although rather common in the ores, pyrites has not been observed in contact with roscoelite.

When magnified 70 diameters, roscoelite resembles the variety of pyrophyllite found at Greaser Gulch, Mariposa County. As far as observed, the associated gold is always bright, of good color and amorphous, generally rounded as if water-worn.

The other mineral associates of roscoelite are calcite, and a yellow mineral, which is probably marcasite or chalcopyrite, found only in microscopic quantities.

The only other known locality of roscoelite in the State, is Section 31, Township 11 north, and Range 10 east, two miles from the Sam Simms mine. Big Red Ravine is on this section, lying only two miles from the site of Sutter's mill, where gold was first discovered. It was one of the earliest placer mines known in the State, and so rich did it prove, that it has paid to rework as many as seven times. It is in the bedrock of these old workings that roscoelite is found.

I am indebted to Mr. George W. Kimble, surveyor of El Dorado County, for valuable information and for specimens of this rare and interesting mineral—with him I walked over the ground while he pointed out the localities. The largest mass found here was taken out by a Chinaman and is described as having been as large as a gallon measure. From first to last 400 to 500 pounds of roscoelite have been obtained, all of which was wasted in extracting the gold.

I was only able to obtain for the State Museum a thin piece of quartz of a few inches superficial surface, coated on both sides with roscoelite; some large masses showing the mineral in spots, and some beautiful microscopical specimens containing gold.

At the Red Ravine locality, roscoelite is found in a dark colored bluish micaceous rock in small seams of quartz and calcite with gold. This rock has not yet been studied.

Through the politeness of Mr. James Taylor, of Owen's College, Manchester, England, I have been furnished with the following analysis of roscoelite.

Analysis of roscoelite by Prof. H. E. Roscoe, of Owen's College, Manchester, England:

Silica	41.25
Vanadic acid (V, 2; O, 5)	28.60
Alumina	12.84
Sesquioxide of iron	1.13
Oxide of manganese (Mn., 3; O, 4)	1.10

Lime	.61
Magnesia	2.01
Potash	8.56
Soda	.82
Water combined	1.08
Moisture	2.27
Total	100.27

The following is quoted from a paper, published in 1877, by Professor F. A. Genth, "On Some Tellurium and Vanadium Minerals," contributions from the laboratory of the University of Pennsylvania:

ROSCOELITE.

It will be remembered that almost simultaneously Professor H. E. Roscoe and I investigated the mineral which now bears his name, his paper having been received by the Royal Society, on May 10, 1876, (Proceedings Royal Society, XXV, 109,) whilst mine was written and sent to the editors of the *American Journal of Science*, on May 16, 1876.

I regret that in some of the essential points our results do not agree.

From the nature of the material and the information received from Dr. James Blake, of San Francisco, no doubt can exist that that which he had sent to me was as good and pure as could be obtained. In my examination (*American Journal of Science*, 3, *XII*, 32), I showed that even the apparently purest scales, selected with the greatest pains, were not altogether free from admixtures. With the greatest difficulty I obtained enough of almost pure scales (containing only 0.85 per cent of quartz, gold, etc.) to make one analysis, which, as it was made with the greatest care, must be a very close approximation of the truth. The material of the other analysis was far more contaminated, and the results were given merely for comparison, and to show the influence of the admixtures upon the analysis.

From Prof. Roscoe's analyses it does not appear that he attempted to separate the impurities by chemical means, and thus he gives the composition of the whole mixture.

He assumes the vanadium to be present as pentoxide, the iron as ferric oxide, the manganese as manganic oxide, the two latter as replacing alumina; and magnesia, lime, and soda as replacing potassium oxide.

As I have made a direct determination of the state of oxidation of the vanadium, I can say *positively* that, if any, only the smaller portion of the vanadium is pentoxide. I found the composition of the vanadium oxide to be $V_6O_{11}=2\ V_2O_3,\ V_2O_5$; but as it was obtained after allowing for the oxidation of ferrous into ferric oxide, and as the quantities of ferrous oxide have been found to vary from 1.67 to 3.30 per cent, it is not impossible that an insufficient quantity of oxygen has been deducted, and that the whole of the vanadium is present as V_2O_3.

Pure roscoelite contains no manganese; in Prof. Roscoe's analyses 0.85—1.45 per cent of manganic oxide have been found, which confirms my opinion that his material was not pure; but what is most astonishing to me is the very low percentage of silica which he finds.

From his analyses he calculates a formula, and from this the percentage composition, which, however, is far from corresponding with his analyses, as for instance:

Silica found	41.25, calculated, 41.18
Potassium oxide found	8.56, calculated, 14.24

I had not calculated any formula from my analyses, being in hope that I may yet be able to procure this interesting mineral in a still purer state for further investigation. For comparison I will insert my analysis (*a*) which certainly closely represents the true composition of roscoelite, and will add the formula corresponding with the same, with this alteration, however, that I consider all the vanadium as V_2O_3. It contains, after deducting 0.85 per cent of quartz, gold, etc.:

	Found.	Calculated.
SiO_2	47.69	49.33
Al_2O_3	14.10	14.09
V_2O_3	20.56	20.62
FeO	1.67	1.64
MgO	2.00	1.83
Li_2O	Trace.	----------
Na_2O	0.19	----------
K_2O	7.59	7.55
Ignition	4.96	4.94
	98.76	100.00

The analysis agrees with the formula:

$$\overset{I}{R}_2 \overset{II}{R} \overset{VI}{R}_2 Si_{12} O_{32} + 4 H_2O$$

$$\overset{I}{R} = K$$

$$\overset{II}{R} = Mg : Fe = 2 : 1$$

$$\overset{VI}{R} = Al : V = 1 : 1$$

or, $K_2 (MgFe) (Al V)_2 Si_{12} O_{32}$
as will be seen from the calculated per cent.

From my repeated examination of the mineral microscopically, I am convinced that it would be extremely difficult to obtain sufficient roscoelite for a chemical analysis, perfectly free from admixture.

Since the publication of the second annual report, a fine specimen of roscoelite has been presented to the State Museum, which is mixed with gold to the extent of seemingly half the bulk of the specimen. It was presented by Richard Sparling, and is numbered (5768). It is from the Tip Top vein, Section 7, Township 11 north, Range 10 east, El Dorado County. There is about a foot of quartz disseminated through the vein, in small bunches, connected with which are seams of roscoelite, generally very thin, from the thickness of paper to half an inch. Occasionally a bunch of roscoelite appears, from which specimens like No. 5768 may be obtained, but these are extremely rare. Mr. Sparling says that at the Sam Simms mine, the owners once took out of a pocket $11,000. A great deal of free gold has been washed from the sides of the hill, below the vein, which came, without much doubt, from decomposed roscoelite, and it is more than probable that the gold discovered at Sutter's mill, in 1848, and that taken from Big Red Ravine, were from the same source. In the Tip Top there is a sheet of what seems to be sandstone; when this and the brown slate come in contact, gold and roscoelite are found.

RUBELLITE—see Tourmaline.

RUBY SILVER—see Pyrargyrite and Proustite.

128. RUTILE. *Rutilus*, Red (Latin). Titanic Acid.

Is found at Long Valley, Plumas County (Edman); and frequently in acicular or capillary crystals in quartz. No. 3747 is a specimen of this character from Humboldt County, Nevada, and there are other specimens in the Museum from other localities. Titanic acid has few applications in the arts; it is used in porcelain painting, and to give color to artificial teeth.

129. SALT. Halite.

The manufacture of salt in California was described in the second report of the State Mineralogist, 1882, folio 217, and locations of known salt beds, salt shipped, etc., given.

The condition of this industry has not greatly changed within the past two years. The most notable feature of the business developed during this period, is the largely increased product of domestic salt, due mainly to the extended operations of the Union Salt Company. Prices have ruled low by reason of the market being heavily stocked. In the early part of 1883, Liverpool salt, from ship, sold as low as $11 50 per ton, but afterwards advanced to $15. The price in San

Francisco varies now from $6 to $23 per ton, the latter for the best table salt. What tends to keep prices depressed is the low rates at which this commodity can be brought to this port by ships coming here to load with wheat, invoices selling very often for barely enough to pay freight and charges.

The quantities of salt supplied to this market and the sources whence obtained, are shown by the following statement:

Imports.	1880.	1881.	1882.	1883.
English, pounds	13,828,066	7,746,408	12,841,212	8,543,878
Carmen Island, pounds	3,542,000	2,730,000	761,600	21,046
Peru, pounds	------------	------------	1,200,000	------------
Receipts, California, tons	9,397	13,275	14,395	21,039

To the receipts of California salt at San Francisco, as above denoted, there should be added about 9,000 tons made in the State, but not sent to the city, it having been shipped directly from the works to other markets and points of consumption. The total product of California in 1883 may be set down, therefore, at about 30,000 tons, being the largest by one third made in any one year in the history of this industry. As will be seen by reference to the above statement, while the home product has been so increased, imports have been diminished in a corresponding ratio; importations from Liverpool in 1883, as compared with those of 1882, having fallen off about one third; the disparity in importations of Mexican salt for these two years having been much greater, while in the case of Peru they ceased altogether.

The rate at which this business has grown in California is indicated by the following table:

	1860.	1870.	1880.
Bushels made	44,000	174,855	884,443
Value	$7,100	$48,150	$121,250
Wages paid	$5,400	$13,400	$49,120

At no time since it was commenced has this business advanced more rapidly than during the past three years, the quality of the article turned out having meantime undergone much improvement. At one time none of the California made salt was considered fit for meat packing or dairy use; now, much of it is employed for these purposes, being little, if at all, inferior to the best Liverpool.

The capital invested in the salt business in California approximates now half a million dollars—number of men employed during the active season, three hundred; value of yearly product, $300,000; wages paid out, $70,000. The Union Salt Company, the largest producers in the State, have increased the capacity of their works of late to the extent of two thousand tons per year, some of the other Bay companies having also enlarged their works somewhat. A well near Yreka, Siskiyou County, bored to a depth of 675 feet, is said to discharge ten thousand gallons of salt water per hour, from which salt is being produced by graduation, thus described in the second annual report:

"In climates less temperate, or unsuited for rapid evaporation, the weak brines, or sea water, are first subjected to a process called 'graduation.' Large buildings are constructed, open at the sides, from thirty to forty feet high, eighteen to twenty-five feet wide, and sometimes two thousand feet long. The building is set at right angles with the prevailing winds. The floor consists of a basin of concrete or hydraulic cement, with walls three feet high. In this basin is piled an immense mass of faggots of oblong shape, and somewhat smaller in size than the building. The brines are pumped up into shallow wooden pans or troughs, overlying the pile of brushwood. The troughs are pierced with a multitude of small holes through which the brines percolate in small streams.

"As the liquid trickles down through the brushwood, it is exposed to the air in thin strata, and becomes rapidly concentrated. It sometimes requires to be pumped three times before it attains the density of twenty-five degrees Beaumé, when it is run into crystallizing vats. This operation, indispensable in some climates, and under some conditions, is unnecessary on the shores of San Francisco Bay, where the air is dry during a great portion of the year, during which no rain falls to interfere with the evaporation, and where extensive salt marshes afford ample room for salt gardens.

"Sulphate of lime forms on the faggots as an incrustation, which, in time—from five to eight years—so fills the interstices that the pile becomes worthless, and must be replaced by another. The graduation process is not new. In 1812, Thompson, in his travels in Sweden, saw, at the copper mines at Fahlun, natural solutions of sulphate of iron (from which the copper had been precipitated by scrap iron), concentrated in this manner. On pumping the extremely dilute solution up seven times, it had nearly reached the point of crystallization, when it was conducted into suitable lead-lined pans, in which it was evaporated by heat to the required density and run into crystallizing vats.

"This economical method of concentration might be practiced to advantage in various metallurgical operations in California, and the pumping done by large windmills built and managed on the Dutch plan.

"A more detailed description of graduation may be found in Lippincott's Encyclopædia of Chemistry, volume 2, folio 733, with an engraving showing mode of construction in Precis de Chimie, by L. Troost, Paris, 1873."

A NEW ENTERPRISE.

During the past year, a new enterprise directed to the production of salt in California has been set on foot, the site of this undertaking being the extensive saline near Dos Palmas, a station on the Southern Pacific Railroad, in San Diego County, and distant 135 miles southeast from the city of Los Angeles. The saliniferous deposits at this point, occupy the dry bed of an ancient inland sea or lake, and consist of layers of crystallized salt, interstratified with thin seams of clay and sand, the salt bed here resembling, in this respect, others found in southeastern California, also in Arizona, Utah, and Nevada. Digging down through this mass, three fourths of which consists of salt, to a depth varying from five to ten feet, a supersaturated brine is encountered, which, entering the excavation, soon fills it with a solid mass of salt, so rapidly does evaporation go on in this hot and arid climate. Salt can, of course, be produced here very cheaply, nothing more being required than to shovel up this material on a wooden platform, and there leave it to drain for a few hours, when it is ready for sacking and shipping. Where an absolutely pure article is required, salt will be produced by evaporating the brine, which can be effected readily without recourse to artificial heat, the temperature of this *sink*, which is 265 feet below sea level, ranging from 100 to 130 degrees for seven or eight months in the year.

This is the region described under the head of "Mud Volcanoes and Colorado Desert," folio 227, of the second annual report. At the sink of this desert basin, the Liverpool Salt Company of California have put up the necessary plant for producing this staple on a large scale, a railroad, two miles in length, having recently been completed, connecting their works with the Southern Pacific track at Dos Palmas. This company is now in successful operation, supplying the product of their works to Southern California and Western Arizona, a trade which their geographical position will enable them to always command. An analysis of this salt recently made, is said to have given the following results:

Chloride of sodium	97.76
Sulphate of sodium	.70
Chloride of iodine	.27
Moisture	.96
Insoluble matter	.20
	99.89

130. SASSOLITE.

Native boracic acid is known to the mineralogist as Sassolite, or Sassoline, named from Sasso, in Italy, where it was first found in a solid state by Mascagni. It occurs also abundantly in the extinct crater of a volcano in one of the Lipari Islands, near Sicily, as mentioned elsewhere, at which locality it was discovered in 1813 by Dr. Holland. It is found, also, in crevices and fissures in the craters of active volcanoes. During the eruption of Vesuvius, in 1851, this mineral was deposited in fissures in Torre Del Greco. It has been obtained, also, from the crater of Stromboli, an active volcano on an island of the same name, one of the Lipari group. It exists, also, in solution in mineral waters of Germany and elsewhere, notably Wiesbaden, Aachen, and Krankenheil.

Boracic acid, free or combined, is of common occurrence on the Pacific Coast. It has been detected in the waters of the ocean along the shores of California and Oregon. Common salt, made by evaporating the sea-water, contains more than traces of boracic acid. According to Professor W. P. Blake, it occurs in a free state in the water of Clear Lake. The discovery of this acid in mineral water in Tehama County led to the examination of other springs then known, which resulted in the finding of boracic acid in nearly all of them. It was discovered at the mud volcanoes in San Diego County by Dr. Veatch, which was verified by my own observation.

Sassolite, of the books, is said to crystallize, in the triclinic system, but all the specimens I have seen show under the microscope a confusion of broken scales without any well defined crystals. When magnified it has almost exactly the appearance of selenite, with the same apparent cleavage and pearly luster. When closely examined, obscure hexagonal plates, imbedded in the pearly mass, may sometimes be distinguished.

Sassolite fuses easily, coloring the blowpipe flame at the same time transiently green; gives water in a closed glass tube; color, white-yellowish, and sometimes a dirty brown; hardness, 1 to 1.48; chemical formula, BO_3+3HO.

PERCENTAGE COMPOSITION.

Boracic acid	56.45
Water	43.55
	100.00

Satin Spar—see Gypsum.

131. SCHEELITE. See also Cuproscheelite.

This mineral is named after the Swedish chemist, Scheele. It is a tungstate of lime ($Ca\,O\,W\,O_3$), consisting of:

Tungstic acid	80.6
Lime	19.4
	100.0

H=4—4.5, sp. gr.=5.9—6. Color, from pale yellow or nearly white to orange yellow, sometimes light shades of brown, green, or red; luster, vitreous; streak, white; brittle, B. B. in forceps, fuses somewhat difficultly, soluble in borax to a transparent glass, which becomes opaque on cooling; decomposed by boiling hydrochloric acid.

Only one locality is known in the State. 4055 is from the footwall of a gold mine on Howard Hill, Grass Valley, Nevada County, where it is said to occur in considerable quantity.

The color of this mineral is yellow, streak lighter, B. B., fusible, with intumescence. In hydrochloric acid it is decomposed, leaving a residue of tungstic acid; the acid solution with metallic zinc takes a deep blue color, and gives reactions for lime and iron. Under the microscope the mineral shows the vitreous luster of scheelite, which is obscure to the unassisted eye. Tungistic acid, which can be cheaply made from this mineral, has certain uses in the arts, among the most important of which is the preparation of incombustible cloth. Dresses and theatrical scenery dipped in a solution of tungstate of soda and dried, will not ignite when brought in contact with flame. In England and other countries, light muslin dresses and draperies are treated with tungstate of soda in laundries. Tungstate of soda is also used for setting colors in calico printing. Tungtate of lead is sometimes substituted for white lead in painting, and tungstic acid, which is oxide of tungsten, is employed in coloring yellow.

Schorl—see Tourmaline.

Selenite—see Gypsum.

Semi-Opal—see Quartz.

132. SEPIOLITE. Meerschaum, Hydrous Silicate of Magnesia.

No. 4263 in the State Museum, from the Half Dollar mine, Inyo County, resembles sepiolite, but as yet no analysis has been made to determine it.

133. SERPENTINE. Chryotile, Picrolite, Retinalite.

So called from its resemblance to the skin of a serpent, is found in such large masses or beds that it is also classed with the rocks. These rocks are metamorphic, not eruptive as formerly supposed, and it is believed that the original mineral was olivine. It is a granular or compact rock occurring in irregular rather oval shaped masses in schistose rocks, or in distinct dikes or veins intersecting other rocks. The prevailing color is a dirty green, but it is found also nearly black, to golden or honey-yellow, as retinalite (or precious serpentine), and some varieties are mottled and shining. Prof. Hunt thinks it may have been a sedimentary deposit from sea water. Altogether serpentine is a very interesting rock, and affords a wide field for the investigations of lithologists. Serpentines contain included in them, several characteristic and important minerals, as chromic iron, olivine, enstatite, and magnetite. Chrysotile, which is found intersecting serpentines in fibrous silky sheets, is a variety of serpentine. When intermingled with dolomite, magnesite, or calcite, serpentine becomes ophiolite, or verde antique. Serpentine cut into slabs is called serpentine marble (see building stones).

It is very common and abundant in California. The following localities are represented in the State Museum: (8.) With microscopic section. (4722.) Peninsula of San Francisco. (488 and 512.) Bear Valley, Mariposa County. (513.) Three hundred yards northeast of the Pine Tree mine, same locality. (544 and 555.) Fort Point, San Francisco County. (580.) Yuba County. (1270 and 1271.) With aragonite. Corner of Market and Guerrero Streets, San Francisco. (1318.) Market Street cut, near Guerrero Street, San Francisco. (1439.) Maryland mine, Grass Valley, Nevada County. (1540 and 1539.) Polished. Lone Mountain cemetery, San Francisco. (1724.) Schistose. New Almaden quicksilver mine, Santa Clara County. (2121.) Yuba River, Nevada County. (2778.) Polished specimen. Kelseyville, Lake County. (3415.) Bald Prairie, Placer County. (4087.) Serpentine rocks. Goleta, Santa Barbara County. (4146.) Monterey, Monterey County. (4960.) Near Red Hill, Butte County. Serpentine is also found on Claremont Hill, Plumas County (Edman); at Pine Grove, Cloverdale, Sonoma County; at Gilroy, Santa Clara County; Corral de Tierra, Monterey County; McCloud River, Shasta County; with cinnabar, in the 1,400 foot level of the New Almaden quicksilver mine, 30 feet from hanging wall, Santa Clara County; and elsewhere in the State. Retinalite occurs, green and translucent, at Meadow Valley, Plumas County (Edman); also in Napa County; and in beautiful specimens, with chrysotile, on the McCloud River, Shasta County.

SESQUICARBONATE OF SODA—see Trona.

134. SIDERITE. Named from the Latin word for Loadstone, or Magnet. Spathic Iron, Carbonate of Iron. (FeO, CO_2.)

Carbonic acid	37.9
Protoxide of iron	62.1
	100.0

This mineral has recently been found by J. W. Redway, in quartz ledges in Tejunga Cañon, Los Angeles County, and is represented in the State Museum by No. 3712.

Silicified Wood—see Quartz.

Silicate of Copper—see Chrysocolla.

135. SILVER.

CHEMICAL AND PHYSICAL PROPERTIES.

Silver is the most beautiful and the brightest of metals. Its pure white color, luster, tenacity, malleability, the facility with which it can be melted and cast into any desired shape, and its permanency, are properties which have made it a favorite metal from the earliest times.

It is one of the *noble metals*, by which is meant that it is permanent under ordinary external influences, and having but little affinity for oxygen, retains its luster.

These properties and its comparative scarcity are the reasons why it is classed among the precious metals.

Silver is one of the few metals which occur in nature in a metallic state, and for this reason was among the earliest known. When native, it is found crystallized in the first system, generally in cubes and octahedrons; sometimes in dendritic, fern-like shapes, which, on closer examination, may be seen to be strings of cubes or octahedrons, which are very beautiful under the microscope. It frequently occurs in fibers called "wire silver." These threads are striated, as if pushed out through small orifices in the rock while in a semi-fluid state, and are generally curved.

Although sometimes nearly pure, native silver is generally alloyed with gold, antimony, arsenic, etc.

Silver, although comparatively rare, is found distributed over a large portion of the earth's surface; seldom metallic, often in distinct silver minerals; still more frequently associated with other metals; sometimes alloyed with gold, as "electrum;" at Lake Superior with native copper, not alloyed, but joined to the copper as if precipitated by it from solution; rarely in masses, like placer gold; scarcely without exception in galena and other lead minerals. It is generally extracted from ores which take many complex forms. Much of the silver of commerce is derived from lead, with which it is always associated in greater or less quantities.

Pure silver is very malleable, but not so much so as gold; its specific gravity is 10.47; it melts at 1860 Fahrenheit; crystallizes readily when cooled slowly. The atomic weight of silver is 108, and its chemical symbol (Ag), from argentum, the Latin name of the metal. The alchemists called silver after the moon, "*luna*," from which the name of the nitrate, "*lunar caustic*," is derived.

It dissolves readily in rather dilute nitric acid, but is scarcely acted upon by hydrochloric or dilute sulphuric acids. Hydro-sulphuric acid and sulphide of ammonium precipitate it from its solutions as a black sulphide of silver (AgS). Boiling nitric acid decomposes this precipitate with separation of sulphur. Soda and potassa precipitate from solutions of silver the oxide of that metal, which is insoluble in excess of the precipitant, but dissolves in ammonia. Ammonia also precipitates the oxide from neutral solutions, which readily dissolve in excess. Hydrochloric acid and soluble chlorides precipitate silver as a white curdy chloride of silver (AgCl), which is insoluble in acids, but dissolves in ammonia, from which it is again precipitated unchanged by acids. By exposure to heat chloride of silver fuses to a transparent horny mass. When this compound is found in nature it is sometimes called "horn silver." This mineral is found in California, and is described under the name of cerargyrite.

SILVER MINERALS.

The following is a list of the silver minerals, with the percentage of silver in each. Only those printed in capitals have an economic value. The others are of rare occurrence, and are found in quantities too small to be considered here, except for their scientific interest. Those marked with an asterisk have been found in California:

1.	Rittingerite	——	*14.	PYRARGYRITE	59.8
*2.	GALENITE—variable.		*15.	EMBOLITE	61.07, 71.94
*3.	Sylvanite	3.9, 14.68	16.	Pyrostilpnite	62.3
*4.	TETRAHEDRITE	——	*17.	Hessite	62.8
—.	FREIBERGITE	3.9, 31.29	18.	Xanthoconite	64.0
5.	Styloptypite	8.0	*19.	PROUSTITE	64.67
6.	FREIESLEBENITE	24.3	*20.	STEPHANITE	68.5
7.	Brogniardite	26.1	21.	Naumannite	73.2
8.	Sternbergite	33.2	*22.	CERARGYRITE	75.3
9.	MIARGYRITE	36.0	*23.	POLYBASITE	75.5
10.	Eucairite	43.1	24.	Dyscrasite	78.0
11.	Iodyrite	46.0	25.	Chilenite	86.2
*12.	STROMEYRITE	53.1	*26.	ARGENTITE	87.1
13.	Bromyrite	57.4	*27.	NATIVE SILVER—nearly pure.	

All compounds of silver, when mixed with carbonate of soda, give in the inner flame of the blowpipe, *brilliant, white, ductile, metallic* globules, which make no incrustation on charcoal, unless the heat is too long continued, when a slight red sublimate is formed. By these reactions silver may be distinguished from all other metals.

One grain of silver is worth	$0.0026936
One gram	0.0415622
One troy ounce	1.292929+
One pound avoirdupois	18.85+
One ton (2,000 lbs.)	37,700.00
One cubic inch	7.14
One cubic foot	12,337.92

ASSAY OF SILVER AND GOLD.

Silver ores so generally contain gold that both metals are included in the silver assay. The assay may be made by fusion in crucibles, with the proper fluxes, or by *scorification.* Many assayers consider the crucible assay the best, but experience has convinced me that scorification gives the most correct results, always supposing the operator to be a skillful manipulator. To allow the reader an opportunity to practice both, both methods will be given in detail:

CRUCIBLE ASSAY.

Before a crucible assay can be properly made, the ore, if containing sulphur, must be roasted, and if not already fine it must be pulverized and sifted. A mechanical loss of the precious metals may occur in roasting unless the greatest care is taken in the manipulation, and if the temperature is too high. During the stirring which is necessary, there is danger of small portions of the ore being thrown over the side of the vessel and lost. This loss should be carefully guarded against.

To determine if a sample of ore contains sulphur, it is only necessary to throw a small portion of its powder on a piece of red-hot iron. If that element is present, the smell of burning sulphur will be perceptible; otherwise the operation of roasting may be dispensed with.

The amount taken for assay depends on the supposed richness of the ore. If very rich, 10 grams, or even 5 may suffice; but ordinarily $29\frac{166}{1000}$ grams, or 29.166 milligrams, for convenience of calculation. This weight being taken, each milligram of silver or gold obtained will be equal to one troy ounce of metal in the ton of 2000 pounds, because one pound avoirdupois is equal to 14.5833+ troy ounces; therefore, $14.58333+\times2000=29166$. This weight is called the "assay ton," as in all ore assays the returns are made in troy ounces, it is found convenient to employ this unit as the basis for all ore assays. This unit was first proposed, I believe, by Professor Chandler of New York, and is now generally adopted by American assayers.

The weight of the pulverized ore is carefully transferred to a shallow dish of burned clay—a scorifier being suitable if it is to be roasted—and placed in the mouth of a hot muffle, where the heat is not too great. The vessel must be frequently turned until all the water has been expelled. The scorifier must then be pushed forward to a point where the heat is greater. When fumes begin to pass off, the assay must be stirred. This is done with a piece of bent iron wire, one end of which is fixed into a wooden handle.

If the heat is raised too suddenly, the assay is likely to partially fuse, in which case perfect roasting is impossible unless the scorifier be removed and the contents cooled and pulverized before making a second attempt, but as a loss by such treatment is nearly certain, it is better to weigh out a new charge and make a second trial with more care.

As the roasting progresses, the assay becomes less and less fusible and may be gradually pushed back to the hottest part of the muffle, until it has attained a red heat and no more fumes or odor are given off.

The assay is then removed from the muffle, allowed to cool, and transferred to a good Hessian or French crucible. Fifty grams of litharge, its own weight of borax, about one gram of argol or charcoal, and a mixing spoonful each of carbonate of soda and carbonate of potash, are put into the crucible with it, and the whole stirred thoroughly with the mixing spoon. The crucible must then be tapped against the table to cause the charge to settle.

To insure the elimination of any sulphur that might escape observation or remain in the ore from imperfect roasting, three large nails are pushed head downward until they nearly or quite reach the bottom of the crucible.

The surface of the charge is then covered evenly with common salt. Upon this are to be placed several lumps of borax; the crucible is then ready for the fire. Two crucibles should be prepared in this manner.

For the fusions a very strong fire will be required. The crucibles may be placed in such position that they cannot fall over, and hot coals are then built up around them. When the contents begin to fuse, a cover is placed upon each crucible and the draft of the furnace so arranged that the greatest heat may be produced. After a few minutes the cover of one of the crucibles must be lifted and the action of the heat on its contents observed. If the charge has melted down and is in a quiet state of fusion, both covers may be removed and that condition maintained for five or ten minutes more. If such is not the case, the cover must be replaced and more time given. It is necessary that perfect fusion should be effected to insure accurate results. When the contents of each are perfectly fluid and intensely hot, the crucibles may be removed, and after tapping against the side of the furnace to cause all particles of lead to gravitate to the bottom, the nails are then removed by seizure, each one in succession with the tongs, and by stirring them about in the liquid flux, wash away, so to speak, the metallic globules that may be attached to them. The crucibles are tapped again and set aside to cool. When cold the crucibles are broken, and the buttons of lead hammered into cubes and cleaned preparatory to cupellation.

When an alloy of lead and silver or gold, or both, is placed in a small cup of bone ashes and exposed to the intense heat of a muffle through which a current of air is caused to pass by the draft of the chimney, the lead first melts, then oxidizes and is absorbed by the bone ashes. This continues until the noble metals are left isolated and pure in the muffle. The cup is called a cupel and the operation cupellation.

The litharge used in mixing the assay becomes metallic lead in the crucible, gathering at the same time the gold and silver in the ore, for which melted lead has a special affinity. The litharge nearly always contains silver; this must be deducted from the assay. The quantity may be known by making exactly the same assay as described above, but using no ore. All the silver obtained by cupellation must, in that case, come from the litharge. Its weight must be noted and deducted from assays as long as the same litharge is used.

After cupellation the next step is to weigh the bead left on the cupel, and to calculate the results. As the bead probably contains gold it will be necessary to separate that metal, and calculate its value also. To do this proceed as follows:

Suppose the bead should be found to weigh 136 milligrams, note the weight, and then place it in a clean test tube, and boil it with pure nitric acid. If no gold is present, it will wholly dissolve. The calculation may then be made on silver alone; the result will be 136 troy ounces to the ton of two thousand pounds. If a black powder remains, fill the tube with distilled water, pour it off carefully, without disturbing the residue; repeat this two or three times; fill the tube again *full* of distilled water; place a *dry cup*, like a cap, over the tube, reverse both; allow the gold to settle in the cup, remove the test tube, by slowly raising it; pour the water in the cup carefully off; dry the gold in the cup, by placing it in the front of the muffle; heat to redness in the muffle; brush out the now bright gold into the pan of the balance, and weigh. Suppose the gold to weigh three milligrams, then:

Weight of silver and gold	136
Weight of gold	3
Weight of silver	133

As each milligram is equal to one troy ounce in a ton of two thousand pounds, the ore is found to contain per ton:

Silver	133 ounces.
Gold	3 ounces.
	136

If it is desired to give a money value to the ore, the following table may be used. The manner of pointing off in similar tables has been given under the head of "bullion assay of gold."

VALUE OF GOLD AND SILVER BULLION IN OUNCES TROY, AND DECIMALS.

Silver.		*Gold.*	
1	$1 29.29	1	$20 67.18
2	2 58.58	2	41 34.36
3	3 87.87	3	62 01.54
4	5 17.17	4	82 68.72
5	6 46.46	5	103 35.90
6	7 75.75	6	124 03.08
7	9 05.05	7	144 70.26
8	10 34.34	8	165 37.44
9	11 63.63	9	186 04.62

Value of the Silver.

100 ounces silver	$129 29
30 ounces silver	38 78
3 ounces silver	3 87
133	$171 94

Value of the Gold.

3 ounces gold	$62 01

Total value per ton of 2,000.

Silver	$171 94
Gold	62 01
	$233 95

ASSAY OF SILVER BY SCORIFICATION.

The scorification assay is made without previous roasting, unless the sample is concentrated sulphurets, in which case it may be roasted in the scorifier as described under crucible assay. The only reagents used are test lead and dry pulverized borax. The ore is mixed with these and fused in the muffle. I generally use for a charge a quarter of the *assay ton*, which is 7.291 grams. If four scorifications are made, the amount of ore treated will be 29.166 grams, which is the same quantity used in the crucible assay.

In mixing the assay, I use a wooden mustard spoon which holds about eight grams of test lead. This spoon has a hemispherical cavity of a little less than half an inch in depth, and a level rim. With a strip of window glass or a knife blade the superfluous lead may be *struck* off, leaving a uniform quantity in the spoon. Previous to commencing scorification, a careful assay of the test lead must be made by cupelling several spoonfuls in separate cupels, accurately weighing the resulting buttons of silver, which must be dissolved in acid. If any gold remains, the lead is unfit for use, and it should be removed from the laboratory, lest it should be inadvertently used in the future. All lead contains silver, but should never be used for assaying if four of these spoonfuls contain more than one milligram. Knowing the amount of silver contained in one spoonful, and keeping a memorandum of the number of spoonfuls used, it will be easy to make the proper deduction at the time of calculating the final results.

Having weighed out four charges of ore, and transferred them carefully to the same number of scorifiers, four spoonfuls of test lead and one of borax are added to each. A sheet of writing paper is then laid on the mixing table, and the scorifiers placed upon it one by one while being mixed. This precaution is taken to prevent loss by portions being thrown out during stirring.

The mixing is done with a piece of sheet-iron four inches long and half an inch wide, or with a small steel spatula. The scorifiers are then ready for the furnace. Several may be placed in the muffle at once. At first the assay is placed in the mouth of the muffle and allowed to heat gradually. When the first action of the heat upon the borax has subsided and beads of lead are seen to form, the scorifier is pushed back to the hottest part of the muffle, and a second one introduced in front. This is repeated until they are all in, or the muffle is full. The door of the muffle is then closed for a time, until the charges have fully fused. The scorifiers are then removed one by one, and while tightly grasped with the tongs, a strong horizontal rotary motion is imparted to them, causing the slaggy covering to break and attach itself to the sides of the vessel, leaving a circular bare spot on the surface of the molten lead. This effected, they are replaced in the muffle, which is not again closed, but the draft of the furnace checked by shutting the lower door, which causes a steady current of air to pass into the muffle, sweeping over the assay and through the small openings, escaping up the flue. Scorification now commences; the borax causes the slag to become liquid. The oxide of lead is seen to form on the surface of the lead bath, moving with a play of colors to the ring of slag, which becomes more and more fluid as the operation progresses. Every particle of gold or silver passes to the lead and becomes alloyed with it.

After a time the slag—from the formation of litharge—becomes so voluminous as to nearly cover the lead. When this is the case, the lower draft is opened, the muffle door closed and the heat raised, to effect perfect fusion of the assays, which are then withdrawn by the aid of the tongs, and poured out into an iron mold, made expressly for that purpose. When cold, the scorifier is broken, and the lead buttons hammered into cubes and cupelled.

Sometimes, but not often, scorification assays work badly, and require more test lead, or more borax. Experience soon teaches the proper addition to make. In either case, a spoonful is wrapped in paper and placed in the hot scorifier by means of a pair of cupel tongs. If more *lead* is added, a memorandum to that effect must be made, and the known quantity of silver it contains deducted. The calculation is the same as described under the head of crucible assay.

BLOWPIPE ASSAY.

Silver assays can be made to advantage with the blowpipe. This assay has the advantage of being simple, and when once understood, is expeditious and accurate; but cannot be explained without engravings of the apparatus used, for which reason it will not be described here. But I would advise prospectors to obtain books and practice this mode of assay. The best work I know of is the "Treatise on the Use of the Blowpipe," by Plattner, translated by Muspratt. This work will give all the information, practical and theoretical, that may be required.

SILVER IN CALIFORNIA.

Not sought for at first—Earliest explorations—Trans-Sierra California—An arid and sterile land.

Being so wholly absorbed in searching after and gathering gold, the inhabitants of California paid no attention whatever to silver during the first decade of the mining era. There were, to be sure, traditions among the native Californians of silver ores having been found in the country prior to its occupation by the Americans—Alisal, in Monterey County, being the site of one of these reputed silver finds. As these Alisal ores have since been shown to be both poor and scanty, it may fairly be presumed that no argentiferous deposits of any value were ever met with in California prior to its transfer to the United States, and not for about fourteen years thereafter. That our pioneer miners, with so little to encourage them, were not much inclined to hunt after silver so long as the more royal metal continued tolerably plentiful, may well be supposed.

Not, therefore, until the discovery of the Comstock lode, with its great promise of silver, was the attention of our people strongly directed to the business of seeking after and mining for that metal; and even after the occurrence of that event most of the explorations carried on, and the mining operations engaged in, were for several years at first conducted outside the limits of this State. Not before the Summer of 1861 did the Nevada prospectors for silver, working south from the Comstock lode, make their way over the line into California; the country first explored by them consisting of the territory at present embraced in Alpine and Mono Counties; the still more extensive region lying further south, and now constituting Inyo County, not having been reached until a year or two later.

The silver field covering these several counties includes all that part of California extending from the summit of the Sierra Nevada to the eastern boundary of the State, a tract comprising more than 10,000 square miles, its length being over 200 and its average breadth fully 50 miles. It is an elevated, rugged, dry, and barren region, and except along the easterly slopes of the Sierra contains very little timber, none whatever suitable for making lumber. It is skirted in part on the east by a high range, the northern extremity of which is known as the White, the central portion as the Inyo, and the southern as the Coso Mountains. This range runs nearly parallel to the Sierra Nevada, Owens Valley, a broad depression over 100 miles long, lying between them. The bottoms along Owens River, which courses through the middle of this valley, comprise about all the agricultural land to be found in the entire district, though the bunch grass, which grows sparsely everywhere, affords considerable pasturage. The general barrenness of this region arises, not so much from the poverty of the soil, as from the aridity of the climate and the limited amount of water to be had for irrigation, without which little can be raised.

GEOLOGICAL FORMATION AND CHARACTER OF ORES.

The Sierra Nevada, which walls in this region on the west, consists largely of granite, the other mountain ranges lying further to the east being composed of the same rock, associated with limestone, dolomite, diorite, porphyry, and syenite; slates occur here, also, in great abundance. The dolomites and limestones appear sometimes capping the higher ridges, while again they occur along the slopes of the mountains in extensive beds alternating with dikes of slate and eruptive rocks. Basalt, columnar in structure, in some places faces the cliffs, while in others the volcanic tufas weathered into pinnacles and spires, form the crests of the broken and castellated mountains.

Not only the higher mountains and their outlying ridges, but also the isolated foothills throughout this tier of counties, abound with mineral veins, earrying both the precious and the useful metals. In some of these veins gold, and in others, silver predominates. Some contain only argentiferous galena, while others carry silver mixed with antimony, lead, copper, arsenic, zinc, nickel, and other baser metals, the presence of which renders these ores exceedingly refractory. While many of these veins are feeble, much broken up, and contain but little ore or only ore of a very low grade, others are powerful, regular, and heavily mineralized, carrying large bunches, and even considerable bodies of high grade ores. Salt, soda, lime, and iron for reduction purposes can be obtained at little cost in most parts of this country, heavy deposits of salt, soda, and borax occurring in the southern and eastern portions of Inyo County, and also just over the line in the State of Nevada at points bordering on Mono County.

ALPINE COUNTY.

The history of silver mining in this county, where the business has now been pursued for twenty-three years, is altogether unfortunate, the product of bullion having apparently been in the inverse ratio of the labor and capital expended on the mines. No portion of trans-Sierra California is so favorably situated as regards access and facilities for cheap mining and ore reduction as Alpine County, nor has any other county been so extensively advertised as this. A good natural and nearly level wagon road connects the mining districts with Carson City, on the Virginia and Carson Railroad, fifty miles distant. This road, through its connection with the Central Pacific, has given for nearly twenty years railroad communication between Carson and San Francisco. All supplies for these mines, machinery included, could, therefore, be obtained during this time at comparatively low rates, Carson Valley and other rich farming districts in the vicinity furnishing all kinds of agricultural products at equally low rates. The mining districts of Alpine abound with wood and water, a considerable portion of them being covered with heavy forests, while a number of large streams flow centrally through them, affording much water power. The mountains in which the mineral-bearing veins occur are for the most part very steep, making it possible to open up these veins to great depths by means of comparatively short tunnels. Existing conditions being so favorable for cheap ore extraction and reduction, the ill success that has attended mining operations here cannot justly be attributed to them. The miners of Alpine and their representatives have complained that capitalists, being ignorant of or not appreciating the advantages of that section of country, have failed to invest in the mines there to the extent warranted by their obvious merits.

The Director of the Mint, in his last published report, speaking through one of his assistants, voices the above complaint in the following language:

> The mining interests of Alpine County still remain, to a great extent, neglected by capitalists, although the showing is of the very best. The mines have been discovered a number of years, and the facilities for reaching them from the centers of population are of the best; the climate cannot be excelled—a great abundance of wood and water—all these facilities for working our mines cheaply and profitably, seem rather to deter mining men from coming here, and instead, seek investments in more inaccessible and disadvantageous regions.

In so far as the foregoing is intended to convey the impression that but little capital has been invested in Alpine County, it is not strictly in accordance with the facts of history. A great deal of money (not less certainly than a million dollars), all supplied from outside sources, has been expended in that county in the furtherance of mining operations there. Mills were built for crushing, and furnaces put up for roasting the ores; shafts were sunk, and hoisting works erected over them; long and expensive tunnels were driven into the lodes, opening some of them up to great depths; roads were excavated for transporting the ores from the mines to the reduction works—the most of these improvements, all made at an early day, having been of a costly and serviceable kind. And yet, with all this financial aid, furnished so liberally and so early, not enough bullion has ever been produced in Alpine County to reimburse the money expended by these investors, even if the proceeds of the mines there had been applied to that end, which unfortunately they were not. It is doubtful, in fact, if these investors have ever received back a single dollar of the many laid out in that district. Few of them retain any interest there, the most of the properties in which they were interested having, through abandonment, been suffered to fall into the hands of others. The value of the bullion produced in this county has for some time past been at the rate of about $30,000 per year, two thirds of it silver, the annual product having at no time been much in excess of that sum.

That mining operations in Alpine have resulted so badly has been due not so much to a lack of capital as to the poverty of the mines and the intractable character of the ores, combined with other difficulties, which in the future may be overcome.

There are a great many gold and silver-bearing veins in this county, but the bulk of the ores are base, low grade, and occur in bunches, no large bodies of very rich ore having yet been developed there. With improved processes, cheapened labor, and better management, such as time may be expected to bring, mining for the precious metals will yet be carried on here largely and with fair profit. As may be inferred from the small product of bullion made, very little is now being done in this county. Although a number of mines are being worked in a small way, not more than two or three of the mills formerly put up are at present being run, and these for only a portion of the time. There are not now over two hundred men engaged at mining in the entire county, though the number amounted at one time to several thousand.

MONO,

Though essentially a gold producing county, contains a number of promising silver-bearing localities, the most noted of these being in the Patterson District, situated in the Sweetwater Mountains, an outlying easterly spur of the Sierra Nevada. This district lies twenty miles north of Bodie, the principal mining center and county seat of Mono. The veins here are numerous and carry a free milling silver ore of high grade. It occurs in chimneys, some of which are apparently of large size. One mill has been put up in the district, and for more than a year past has been making a large and profitable production of silver. It is probable that others will soon be built, and, taken altogether, the outlook for these mines may be considered very encouraging.

Stretching along the easterly slope of the Sierra Nevada, and at an elevation of about 8,000 feet, is an argentiferous belt, having a linear extent of nearly fifty miles. Along this belt several mining districts have been formed; but in none of them, except the Tioga, has much effective work been performed. In this district the Great Sierra Company has run a tunnel that intersects their ledge at a depth of nearly a thousand feet, cutting a good ore body, but beyond this very little else has been done here. In the Homer District, on this range, where a mill has been put up and a good deal of exploratory work done, the veins are mostly gold bearing. In the Montgomery District, at Hot Springs, Partzwick, and about Benton, in the southeastern part of the county, occur silver-bearing deposits, some of which have been worked at intervals, and with good average results, for many years past. These ores are generally of high grade.

INYO COUNTY.

While this, like Mono, is both a gold and silver-bearing county, the latter is here the predominating metal, some of the mines having turned out silver in large values.

This region was first visited by prospectors in 1860, who were looking for gold, and the fabulous "gun-sight lead." A somewhat detailed account of these early explorations may be found in the third annual report, folio 33, the section then explored consisting of the country lying to the east, south, and west of Owen's Lake. Several small stamp-mills were put up here during the following two or three years; but the remoteness of the district, and the hostility of the Indians so interfered with operations, that the country was for years practically abandoned.

Bishop Creek, an agricultural valley, and Owen's Valley, were settled in January, 1862. The Indian war broke out in February, and the battle of Lone Pine was fought March 22. Colonel Geo. S. Evans arrived with troops, and established Camp Independence, April 5, of the same year. From that time until 1865, there were a succession of Indian outbreaks, although prospecting was still carried on, and the county was proved to be a rich mineral region. After this date, the business of mining for the precious metals was carried on with vigor and success at several different points in the county; the most active and largely productive localities since having been the Cerro Gordo, Beveridge, Deep Springs, Darwin, Bishop's Creek, Inyo, and Panamint districts.

Taken altogether not less than twenty-five or thirty mining districts have been formed in Inyo County, many of which have, however, failed to maintain their organization. Three fourths of these are situated in the east lying chain of mountains, the remainder being located in the lower ranges between these mountains and the main Sierra and along the easterly slopes of the latter. In two thirds of these districts the prevailing metal is silver, the deposits being worked as silver mines. Some of the metalliferous veins here carry only gold, some only silver, while others carry these metals, either one or both, intermixed with lead, copper, antimony, etc. Some of these ores are free milling, though the greater portion require special metallurgical treatment.

The value of the bullion taken out in these several counties amounts, probably, to a total of twenty million dollars, nearly three fourths of it consisting of silver, and mostly the product of the Cerro Gordo mines.

THE CERRO GORDO DISTRICT,

Situated in the Inyo Mountains, 12 miles easterly from the upper end of Owen's Lake, and at an attitude of 7,000 feet above sea level. These mountains are at this point exceedingly sterile and afford but little wood or water. They are composed mainly of metamorphic slates traversed by belts of limestone and porphyry. The metalliferous veins here occur either altogether in the limestone or at the line of contact between it and the slates. The most of them dip from 60° to 70° to the southwest and have a northwesterly and southeasterly strike, running nearly with the longitudinal axis of the principal range of mountains. They consist of two classes, those which carry argentiferous galena and those which carry chiefly copper, the vein matter in the first being composed of limestone and in the latter of quartz and quartzite. Although work began here as early as 1868 not much bullion was taken out until 1872, the mines previously having been operated in a small way and for immediate results. From 1873 to about 1879 the value of the silver taken out here averaged over $1,500,000 per year, and as the ores were mined and beneficiated at a moderate expense, the profits realized on this production were large. While a number of small companies have continued work here, the larger companies and principal bullion producers have done very little for the past four or five years, the more prolific ore bodies having been exhausted. Of late the work of exploration has been partially renewed in the well founded hope that new ore bodies will be developed.

These Cerro Gordo ores consisted largely of the carbonate and the sulphates and sulphide of lead, and on an average yielded twenty per cent lead and about $60 in silver to the ton. The base bullion, which was worth about $300 per ton—lead, silver, and gold—was sent to the Selby works at San Francisco for parting and refining. The scarcity of water at these mines necessitated the laying down of pipes to a spring ten miles distant. To pass this water over interposing ridges of the Inyo range it had to be lifted to a height of 1,860 feet, which was accomplished through the agency of three Hooker steam pumps placed 3,800 feet apart, each pump overcoming a vertical lift of 620 feet. These works were completed in May, 1874, at a cost of $74,000, after which water was supplied to the inhabitants of the town at the rate of three cents per gallon, less than half of what it had before cost them.

Several years since a mining excitement carried quite a large population into the Panamint District, situated in the southern extremity of the Coso Mountains. But the movement resulted disastrously to nearly all concerned, a vast amount of labor and money having been expended in the construction of roads, building towns, and putting up reduction works not warranted by the character of the mines. This Panamint fiasco illustrates very forcibly the impolicy of making costly improvements in advance of ore developments.

Recently there has occurred some revival of mining operations at various points in Inyo County, this increased activity being due in part to more careful and economical modes of procedure, but mainly to the advent of the Carson and Colorado Railroad in that region, whereby the cost of working the mines and shipping out their products has been greatly reduced.

SAN BERNARDINO COUNTY.

During the past two or three years a very extensive and promising silver field has been opening up in the Calico and adjacent districts, San Bernardino County; and while it is yet too early to pronounce upon the permanence of the deposits there, indications denote for this region mineral resources of no mean order. Thus far these mines have produced a total of five or six million dollars, and at a comparatively small cost. They have been almost entirely self-supporting, very little capital having been invested, either in opening up or supplying plant to the mines. The ores contain for the most part chloride of silver, easily worked by crushing and amalgamation in pans, after the Washoe plan. The veins occur here of all sizes, though the majority of them are rather small. The ores which are found usually in streaks, bunches, and chimneys, are of a high grade, and, in the claims worked, have been found to hold from the surface as far down as developments have extended, between five and six hundred feet. There are now about 2,000 miners in that region, the most of them working their own claims in a small way, the richness of the ores and the facility with which they can be extracted and disposed of rendering this practicable. At first the ores were nearly all shipped in small lots, and marketed in Oakland and San Francisco; now the bulk of them is worked on the ground, the larger companies owning their own mills, of which there are five or six in the county, while the miners sell most of their ores to the custom mills, which sample and buy them. These sensible and business like methods having been adopted and adhered to from the first, mining has been kept in a healthful and progressive condition, these districts presenting the most satisfactory record of any in the history of silver mining on this coast. No other silver-bearing field has received so little outside aid, nor has any other made such a steady and profitable production from the start.

The Calico, the central and principal mining district in this region, is distant about four hundred and eighty miles southeast from San Francisco, and ninety northeast from the town of San Bernardino, the county seat. It is reached by the Southern Pacific Railroad to Mohave Station, and thence over the Atlantic and Pacific Railroad, which traverses the district centrally in an easterly and westerly direction. The Calico mines yield only silver, but some of those in the outlying districts, of which there are several, produce both silver and gold, the ores here carrying also, in some cases, lead, copper, and other base metals, which render them stubborn of reduction. These districts are all included within the limits of the Mohave Desert, a sterile, timberless, waterless region, arid at all seasons, and very hot in the Summer, the great plain that constitutes this desert being but little elevated above ocean level. As the mines are somewhat more elevated, being situated for the most part in the mountains, the Summers here are scarcely so hot as in the plains below. For eight months in the year the climate is pleasant and extremely favorable for the prosecution of outdoor labor, which is little interrupted by cold or stormy weather, there being hardly more than a dozen rainy days in the course of the year. There is little or no snow in the mines, though it falls to a considerable depth on the higher mountains in the neighborhood.

Argentiferous deposits exist at many other points in California besides those above mentioned. Some of these have been worked, several in Shasta County, but never with very encouraging results, the ores being for the most part base and difficult of treatment. As many of these deposits are, however, rich in silver, with wood and water convenient, they will, doubtless, come in good time to be worked to an extent commensurate with their merits. There are on the island of Santa Catalina heavy veins of white quartz carrying much argentiferous galena. An attempt was made many years ago to utilize this ore, but it was found to run so low in silver that the effort was abandoned as unprofitable.

PAST PRODUCTION AND FUTURE PROSPECTS.

The production of silver made in California to date has been, as per table given below, the yield prior to 1871 and for the year 1884 being estimated:

Prior to 1871	$1,000,000	1878	$1,700,000
1871	250,000	1879	2,350,000
1872	750,000	1880	1,250,000
1873	1,000,000	1881	1,000,000
1874	1,700,000	1882	1,500,000
1875	2,000,000	1883	2,500,000
1876	2,500,000	1884	3,500,000
1877	3,000,000		
			$26,000,000

This value represented by pure silver would, if cast, form a cube $12\frac{3}{10}$ feet high, nearly.

That silver mining, as heretofore conducted in California, has proved generally unfortunate, is not to be denied; but in accounting for such lack of success there is this to be said: Our people were at the outset but little acquainted with this business—knew hardly anything about the character of silver-bearing ores, their modes of occurrence, or the proper manner of treating them; and if we had here a few skilled mineralogists and metallurgists to whom we could apply for aid and guidance, the most of these were men who had received their schooling and practiced their callings under circumstances very different from those by which they found themselves here surrounded—so different, in fact, that under these new and strange conditions, denied the conveniences and facilities for operating to which they had been accustomed, these adepts proved almost as much at fault as those who were strangers to the business; the failures for a time, at first, having been in about equal proportions between the novices and the trained experts. Then, as has already been stated, the country where our first attempts at silver mining were carried on was exceedingly barren, isolated, and far removed from points of supply, long chains of rugged mountains intervening between them. This, in the absence of railroads, retarded ore development, while it rendered improvements and operations of all kinds very expensive. Laboring under these difficulties and drawbacks, no very rapid progress could be expected; nor if some mistakes, a few of them not altogether excusable, were sometimes committed, is this to be wondered at? Reviewing the past, and surveying the whole field as it opens before us, we think there is abundant reason to believe that the business of silver mining, promoted by more legitimate means, and aided by better methods, is destined to take its place among the most largely productive, profitable, and enduring industries of California.

Silver Glance—see Argentite.

Slate—see Building Stones.

136. SMITHSONITE. Carbonate of Zinc.

Said to occur with cerusite in the Modoc mine, Inyo County.

137. SODA NITER.

This important mineral is nitrate of soda (NaO, NO_5).

Nitric acid	63.5
Soda	36.5
	100.0

H=1.5—2. Sp. gr.=2.09—2.29. It is soluble in water and has a cooling taste. It deflagrates when heated in a platinum spoon with charcoal. B. B. melts and colors the flame yellow (soda). The desert lands of Southern California, Arizona, and Nevada, resembling those of Peru, Chili, and Ecuador, it has been thought that nitrate of soda would be eventually found here. This prediction has been verified, it having recently been discovered in at least two localities in California and one in Nevada. The site of the most important California discovery, which occurred in April, 1883, is near the town of Calico, San Bernardino County, small quantities of the mineral having been observed at several places in that vicinity. Samples gathered there and sent to the State Mining Bureau for examination, were found to be quite rich in nitrate of soda. But what these deposits are likely to amount to we are not advised, though presumably measures have been taken to determine their probable extent and value, as the district whence these samples came is marked by conditions favorable for the occurrence of this salt.

The Nevada find, the discovery of which dates some two years earlier, is located on the Humboldt desert, at a point eight miles from Lovelock Station, on the Central Pacific Railroad. The nitrate occurs here imbedded in the earth from two or three inches to as many feet beneath the surface. It is found, also, in thin seams in the rocks of the mountains adjacent. While these rocky deposits are of no practical value, they denote the probable sources from which the beds out on the desert were originally derived. The contents of these crevices, where exposed to the rains, are dissolved and carried away, the hot dry weather reproducing them each succeeding Summer. Though scattered over a considerable area, the salt has not, as yet, even in the main deposit, been found sufficiently concentrated to admit of any large quantity of fair grade being collected here. The company who own this ground express a purpose of prospecting it thoroughly, in the hope of finding more valuable deposits of the mineral than have yet been met with.

The geological features, mineral products, and climatic conditions of these northern localities bear a strong resemblance to those of the nitrate-bearing territory of South America. Here, as in the district of Tarapaca, on the coast of Peru, but little rain ever falls. There occur here, also, as there, the borates of lime and soda, also immense beds of common salt and carbonate of soda, with marine shells, denoting that the country was once covered by the ocean, or that it was the bed of an inland sea. Lying to the east of Tarapaca is another extensive nitrate field, but it has been but little utilized, being eighteen miles from the coast, with a barren and sandy stretch of country intervening. Both of these beds are, in fact, located on the great Desert of Atacama, a sterile, treeless, and nearly rainless region, similar to the districts in which the California and Nevada deposits occur. The South American nitrate is usually found covered first by a layer of earth from five to twenty inches in thickness, underlaid by a compact stratum of gypsum, below which the salt occurs in irregular strata and bunches from two to ten feet in thickness, a good deal of it being intermixed with gypsum, salt, and other impurities. The nitrate-bearing lands extend here over an area of forty square leagues. Other finds of this salt have, from time to time, been announced as having occurred in California or elsewhere on the Pacific Coast, but which, on more close examination, have proved illusory, the mineral mistaken for saltpeter turning out to be some worthless substance.

There is said to be a group of springs in the extreme southern part of New Mexico, which deposit the nitrate of soda in limited quantities. No use has as yet been made of this material, except that some of it has been packed away by Mexicans, a portion of these springs being over the line in the State of Chihuahua. That these deposits will become of much commercial importance is not at all probable.

HOW PREPARED.

As nitrate of soda does not occur pure in nature, it has to be refined to fit it for the use of the manufacturer. To this end, the crude material, after being broken into small pieces, is dissolved in boiling water, the earthy and other insoluble matters falling to the bottom. The clear liquor being then drawn off, is run into shallow troughs, where, exposed to the dry and cloudless atmosphere, it soon evaporates, and crystallizes into the nearly pure article of commerce. There are many of these rude refineries scattered over the district of Tarapaca. Iquique is the port whence the refined product from this district is shipped to foreign markets.

USES AND CONSUMPTION IN CALIFORNIA.

The purposes for which this salt is mainly employed, are as a constituent in the manufacture of gunpowder and for making nitric acid.

Owing to its deliquescing tendency, it is unfit for the former use until first properly prepared. Our imports of this commodity amount to about 5,000 tons annually, divided up among the acid and the powder works. The Judson & Shepard works take more of this salt than all the other works in the city, this firm turning out 1,500,000 pounds of nitric acid per year. The nitrate of soda averages in this market about two and one quarter cents per pound by the cargo, our supplies all coming from Peru. Shipments from this point east, over the Central Pacific Railroad, amount yearly to between sixty and seventy thousand pounds.

This Peruvian nitrate constitutes, also, a very valuable fertilizer. Although applied as yet for the enrichment of the soil in only a limited way, its consumption for this use must ultimately become very large. Fortunately for oncoming generations, there is in these South American fields enough of this material, mixed with other fructifying agents, to last, under the heaviest drains likely to be made upon them, for a very long time. The Province of Tarapaca is alone estimated to contain not less than 63,000,000 tons of nitrate.

The value of the nitrate of soda imported annually into the United States has, during the last decade, ranged from $1,000,000 to nearly $4,000,000, the imports of 1882—180,000,000 pounds, the largest of any one year—having been valued at $3,911,545. The imports of this commodity into Great Britain average over 100,000,000 pounds per year.

The method of testing for the nitrates is very simple, although the determination of the quantity contained in a given sample is somewhat difficult. For the prospector, the following test will serve to show whether nitrates are contained in a suspected sample of crude material or not: Nitrates are most likely to be found in dry alkaline sands, alkaline incrustations, and in the floors of caves. The test is made by placing some of the loose earth in a common miner's pan, adding water and stirring from time to time for some hours. If heat can be applied, the solution will be complete in a shorter time. The contents of the pan are then allowed to settle and the nearly clear solution poured off into some convenient vessel. The pan is then washed and the liquor returned to it. This is either allowed to stand in the sun until evaporated to dryness, or more quickly evaporated over a fire. When dry the residue is mixed intimately with an equal volume of charcoal, and thrown on red hot coals, or on a plate of red hot iron; if the substance contains any nitrate the powder will deflagrate like wet gunpowder. This test is very characteristic.

Specular Iron—see Hematite.

138. SPHALERITE. Blende, Zinc Blende, Black Jack, Sulphuret of Zinc.

The name "sphalerite" is from the Greek, meaning treacherous. The original name "blende" is from the German, meaning blind, deceiving, because blende while resembling galena produced no lead. Composition (Zn. S.).

Zinc	67
Sulphur	33
	100

H=3.5—4. Sp. gr.=3.9—4. Color, black, brown, yellow, green; streak, white. Transparent, opaque. In open tube gives sulphurous fumes. B. B. on ch. is not easily melted or decomposed by heat, but if pulverized in an agate mortar and mixed with carbonate of soda, then on ch. it is decomposed and the zinc burns with a greenish flame, and an incrustation of oxide of zinc is formed on the charcoal, which is yellow, while hot, but becomes white when cold. If this incrustation is touched with a glass rod dipped in a solution of nitrate of cobalt, and again heated, it assumes a beautiful and characteristic dark green color. If lead is present in the mineral, which is commonly the case in California, there will be a yellow incrustation also, but the latter test is conclusive. The cobalt solution in this case may be applied directly to the assay.

Zinc blende is very abundant in California, disseminated through the vein matter in gold and silver mines, but has not been found in distinct veins. When concentration is adopted in treating low grade ores, zinc will become worthy of attention, and will be saved and utilized. It occurs at Meadow Lake, Nevada County, in considerable masses, with galena, pyrite, and chalcopyrite; and associated with yellow copper in the Lancha Plana and Napoleon copper mines in Calaveras County (Blake).

It is represented in the State Museum by the following specimens: Nos. 1633, 1632, 1891, in calcite, White Chief mine, Mineral King District, Tulare County; (2154) Dennis Martin's ranch, four miles west of Menlo Park, San Mateo County; (4070) with calcite, Small Hill mine, Santa Catalina Island.

SPHENE—see Titanite.

STALACTITE—see Calcite.

STALAGMITE—see Calcite.

STEATITE—see Talc.

139. STEPHANITE. Etym. *Stephan*, Mining Director of Austria. Brittle Silver Ore, Brittle Sulphuret of Silver.

This is a double sulphide of silver and antimony. (5 Ag. $S+Sb_2 S_3$.)

Sulphur	16.2
Silver	68.5
Antimony	15.3
	100.0

Found in the Morning Star mine, Alpine County (Dana).

140. STIBICONITE. Partzite, Antimony Ochre, Hydrous Oxide of Antimony.

Partzite is found in abundance in Mono County. It seems to be a mechanical mixture of stibiconite with other oxides, and is always rich in copper and silver. It was first analyzed by A. Arents, and the analysis published in the *American Journal of Science*, series 11, volume xliii, page 362, as follows:

Teroxide of antimony	47.65
Oxide of copper	32.11
Oxide of silver	6.12
Oxide of lead	2.01
Oxide of iron	2.33
Water	8.29
	98.51

Color yellow, pea-green to black, generally coated with chrysocolla. H.=3—4. Sp. gr.=3.8. B. B. in forceps, nearly infusible, melting only on the thinnest edges. In closed tube gives much water. B. B. on ch. alone, after some time a coating of antimony oxide is formed. With carbonate of soda, metallic, white, brittle beads are obtained in a yellowish-green slag. The beads on being treated with nitric acid are decomposed, leaving a white residue of antimony; with an addition of hydrochloric acid perfect solution takes place which is golden yellow. On adding ammonia the solution becomes blue (copper), and a slight precipitate of iron and alumina falls. In several specimens I examined, no silver reaction was obtained, although specks of free silver could be seen in the ore. I am inclined to think that the silver is always in a free state, and that the mineral is heterogeneous, and not uniform in its composition. I question if two analyses could be obtained exactly alike. Partzite, named after Dr. Partz, employed in the metallurgy of ores at Benton, Mono County, where the mineral was first discovered, occurs in the same veins with silver chloride, lead and copper carbonates, galena, and iron oxide. The latter contains a compound of manganese not determined, but probably protoxide or carbonate, which, when treated with a hot solution of copper chloride, replaces the copper in the solution (Aaron).

Magnificent specimens with free silver are found in the Diana, Kerrick, and Comanche mines, Blind Springs District, Mono County. It is represented in the State Museum by No. 256, from the Kerrick mine, Benton, Mono County; (2919) from the Comanche mine, Blind Springs, Mono County; (4759), with native silver and galena, from the Tower mine, near Benton, Mono County.

141. STIBNITE. Etym. *Stibium* (antimony). Sulphide of Antimony, Antimony Glance. (Sb_2 S_3.)

Antimony	71.8
Sulphur	28.2
	100.0

H=2, sp. gr.=4.5—4.6; luster highly metallic; color and streak lead-gray, sometimes tarnished black or iridescent. In open tube sulphurous and antimonial fumes are given off, the former recognized by the smell, the latter coating the inside of the tube white; very fusible. On ch. B. B. melts and coats the coal white, giving off at the same time dense white fumes of oxide of antimony. With a small portion of cyanide of potassium and carbonate of soda, at a gentle heat, a bead of metallic antimony is reduced. Soluble in hydrochloric acid and in hot solution of caustic potash, from which nitric acid precipitates orange sulphide of antimony. On adding more acid, the sulphide is decomposed to oxide of antimony and sulphur, which remain insoluble.

Antimony is a brilliant white brittle metal, fusible at a low heat

(797°). When broken it shows an internal lamellar structure, sp. gr.=6.7 to 6.8. Does not oxidize in the air; may be distilled or sublimated at a white heat. In the open air it oxidizes at a red heat and yields dense white fumes of oxide of antimony. It is not attacked by the dilute acids, except nitric and nitrio hydrochloric. By the former it is oxidized but not dissolved, but is wholly so by the latter with heat. It is not certain when antimony was discovered, but it was known to the alchemists and was used in medicine near the end of the fifteenth century. It is seldom found in a metallic state in nature, but occurs combined in numerous minerals and with sulphur in stibnite. Crude antimony, black antimony, the antimonium of the pharmacists, is stibnite purified and concentrated by fusion at a low heat in air tight crucibles or vessels of iron, with an aperture near the bottom, through which the fused sulphide flows, leaving the silica and other impurities behind. From this crude antimony the metal and preparations of the metal are obtained. Besides its use in medicine it is employed in alloys to give hardness to other metals deficient in that property, notably in type metal and anti-friction alloys.

Antimony may be distinguished from all other metals by its brittleness, white color; forming a white powder when boiled in nitric acid. The white coating which it leaves on charcoal when heated; white sublimate in closed tube, and the yellow precipitate produced by sulphide of ammonia in acid solution, which is soluble in excess of the reagent.

METALLURGICAL WORKS.

On the strength of what was considered reliable information, to the effect that there existed an abundance of antimonial ores within easy reach of San Francisco, two establishments were put up for treating this class of ore—the one in Oakland and the other in this city. The former, which was costly and of large capacity, after having been run for a period on an oxide ore, obtained from Sonora, Mexico, was closed down, and so remained until a short time since, when it was accidentally destroyed by fire. The enterprise involved a serious loss, most of it falling on Boston parties.

There was in this case no lack of a tolerably good ore supplied at a moderate cost, yet the venture seems to have afforded no room for profit. The works put up in this city by Messrs. Starr & Mathison, though of limited capacity, have remained a part of the time idle by reason of their inability to obtain enough ore of sufficiently high grade to keep their furnace constantly running. As the cost of reducing this mineral in San Francisco is large, a suitable fuel being expensive, and as they have been obliged to find a market for most of their product in New York, this firm has not sought to handle ore carrying less than fifty per cent metal.

CONSUMPTION, PRODUCT, AND PRICE, IN THE UNITED STATES.

While the consumption of metallic antimony in the United States amounts to some twelve hundred tons per year, the entire country produces hardly more than sixty tons, worth an average of about ten cents a pound. This metal, in its pure state, is too brittle to be used for any purpose except as a mixture with certain other metals to which, as an alloy, it gives hardness. Twenty per cent, added to lead, renders the latter hard enough for printers' type, the largest single use to which antimony is applied. In the mechanic arts it is employed to impart anti-friction properties to Babbitt metal, used for bearings in machinery. It is also used for pharmaceutical purposes.

The consumption of antimony on the Pacific Coast is small, amounting to not more than thirty tons per annum.

To obtain enough ore of the requisite grade to keep their works going for as much as three fourths of the time, Messrs. Starr & Mathison have found to be a difficult matter, notwithstanding high prices are paid for this class of ore.

The California export of this metal, all from San Francisco and Oakland, amounted in 1882 to a little over thirty tons, the value of the ore shipped to England having been $5,850. Both the ore shipments and the quantity of metal made were less in 1883 than during the preceding year.

CALIFORNIA LOCALITIES.

Stibnite has been found in several localities in the State. It is generally, if not invariably, associated with mercury in California, and the same is the case in Borneo, where antimony is largely produced. Stibnite has been found in considerable quantity in Kern County. The antimony mines in San Emidio Cañon, Township 10 north, Range 21 west, Kern County (No. 4092), were discovered in early times. It was supposed by the Indians to be silver ore. It was visited by W. P. Blake in 1854. His description appears in volume 5 of the Pacific Railroad Reports, folio 291. Professor Whitney mentions the locality in Geology of California, folio 189, but places it in Arroyo Plata, west of San Emidio. The ore occurs in large solid masses, bowlders of which are numerous in the beds of the arroyos leading from the vein (Blake).

Mr. S. Boushey, Alex. B. and Geo. Chaffey, and G. H. Howland, have recently commenced work on this mine, and are reducing the ore to matte or crude antimony by economical methods. They use ten iron pots, in each of which one hundred pounds of crude ore are heated in an oven-shaped furnace. The operation requires one hour only. The crude antimony flows through holes at the bottom of the pots. I saw fine specimens of crude antimony from this mine in the rooms of the Board of Trade in Los Angeles. The Alta antimony mine is situated in the McLeod mining district, San Benito County, fourteen miles northeast from Hollister, on Section 30, Township 11 south, and Range 7 east. The company was incorporated April 20, 1875. The present owners are N. P. Sheldon, S. W. Collins, R. H. Orton, and Samuel Ambrose, the last named gentleman acting as Superintendent. Over $2,000 has been expended on the mine. There is a tunnel driven on the vein 207 feet, and a shaft sunk 100 feet. Twenty feet of the shaft is in ore (stibnite, 4099) which occurs in splendid crystals. The vein is solid ore from three inches to two and one half feet in thickness. No stoping has been done. The company has no reduction works. Analysis in Germany showed the mineral to contain no arsenic, lead, or other objectionable matters. The company have no matured plans as to mode of working the ores, but are determined to more fully develop the mine before expending capital on reduction works. At the Stayton mine in the same county the ore is said to exist in large quantities, but that it is not of very high grade may be inferred from the fact that the former owners of this deposit, after expending considerable sums in putting up reduction works, building roads, and otherwise improving the property, were obliged to suspend operations, having found no profits either in treating the ore on the ground or sending it to San Francisco for a market. Besides the rather poor quality of the ore, there existed other obstacles to success, such as costly transportation, the mine being situated in a rugged cañon at a considerable elevation in the Coast Range, and a long way from the railroad, scarcity of timber suitable for making good lumber, etc. The reported discovery of a body of rich ore in the vicinity of this mine, though probably well founded, needs confirmation.

Stibnite is found elsewhere in the State. In washed bowlders, Centennial mine, San Bernardino County; Pacheco Pass, Monterey County; (1631) Mammoth mine, Mineral King District, Tulare County; in the Panamint Mountains, Inyo County, in large veins; at the head of Bloody Cañon, Mono County (4349) with chalcedony, and cinnabar, Lake quicksilver mine, Lake County; (4354) near Kernville, Kern County, and in Santa Barbara County (Dana).

OTHER LOCALITIES WEST OF THE ROCKY MOUNTAINS.

A deposit of antimony ore found at a point twelve miles south of Battle Mountain, in Humboldt County, Nevada, after having been worked irregularly, but with some success, for a number of years, appears to have been so far exhausted that operations upon it have been suspended with little likelihood of their being resumed. Deposits of this ore are said to exist at other points in that State, but nothing determinate is known as to their extent or value. In the Wood River region, Idaho, antimony is found associated with argentiferous lead ores, the same being the case in some of the adjacent Territories.

On the headwaters of the Sevier, in southern Utah, a number of antimony-bearing veins were, not long since, discovered. Some of these veins have been opened up with results that denote for the find a good deal of importance. From one or two of them ore of an excellent quality is being extracted and reduced at the works put up at the mines. Considerable metal is being turned out here daily, and the enterprise promises a favorable issue. What most imperils its success is the long wagon transportation required for getting in supplies and shipping the metal to market, the locality being 60 miles from Milford, nearest station and present terminus of the Utah Central Railroad. Another drawback is found in the generally barren character of the surrounding country, which is also but poorly supplied with timber and water.

142. STROMEYRITE. Etym. *Stromeyer,* chemist who first analyzed it. Silver Copper Glance.

Gives the reactions of chalcosite (which see), except that it contains silver. The proportions are so variable that I have thought it was a mechanical mixture of the two minerals. It occurs with other silver and copper ores in the White Mountains, Inyo County (Aaron), and is not uncommon in the Inyo Mountains, from the White Mountains to Coso.

SULPHATE OF COPPER—see Chalcanthite.

SULPHATE OF IRON—see Coquimbite.

SULPHATE OF SODA—see Thenardite.

143. SULPHUR.

ETYMOLOGY AND MODE OF OCCURRENCE.

The term sulphur is derived from the Latin word *sal* (salt), and the Greek for fire. It is an elementary substance and seems to be a general mineralizer, being found in nearly all mineral veins in some form or another. It occurs in nature generally as a surface, though sometimes as a deep-lying deposit, and usually with gypsum and celestine, resulting from the decomposition of other minerals. It is also found in volcanic craters and solfataric vents, in mineral waters combined with hydrogen, in nature as sulphuric acid, and combined with metallic bases, as sulphides, and in certain organic compounds; is obtained artificially in the purification of coal gas. Sulphur is thought to result from decomposition of two gases, hydro-sulphuric and sulphurous, thus, $2HS+(SO_2=3S+2HO)$; or by the oxidation of hydro-sulphuric acid, thus, $(HS+O=HO+S)$. The oxygen may be derived from the decomposition of water or some secondary reaction. Both these gases are abundant at the mud volcanoes in San Diego County and in mineral waters.

PRINCIPAL USES.

The uses for which sulphur is principally employed consist of the following: The manufacture of gunpowder, sulphuric acid, matches, fireworks, mosaic gold, and for taking impressions of coins, medals, etc. It is also employed in the arts for producing vermilion and ultramarine colors, and for vulcanizing India rubber; in medicine, for purifying the blood, the treatment of cutaneous diseases, and as a disinfectant; in metallurgy, for precipitating silver; in agriculture, for the destruction of insects on plants, vines, etc., no less than 89,600,000 pounds having been consumed during the year 1883 in France, Italy, and Spain for killing the phylloxera in the vineyards of those countries, much being also used elsewhere for this and similar purposes. More of this mineral is employed in the manufacture of sulphuric acid than for all other purposes combined.

ITS CHEMISTRY.

Sulphur when cast in molds is called brimstone, or roll sulphur, brimstone being a corruption of the German term *brennstein*, a stone that burns. When obtained by sublimation, this mineral is known as flowers of sulphur. Its symbol is S; atomic weight or combining equivalent, 16 by the old and 32 by the new system. Sulphur is a moderately hard, inflammable, brittle, opaque substance, insoluble in water; color and streak yellow; sp. gr.=2.07; H.=1.5—2.5; melts at 218 to 227 degrees Fahrenheit; takes fire and burns at 518°. Transparent, translucent; fracture conchoidal; if cooled slowly crystallizes in needles; breaks with a crackling sound that may be heard if a piece be held in the warm hand near the ear; is a non-conductor of heat. Men employed in the sulphur works frequently pour the melted mineral over their fingers, where it congeals without burning them. Applying a number of coatings in this manner, a glove of sulphur is formed which can be removed without breaking. A curiosity of this kind, formed at the Sulphur Bank mine, Lake County, was exhibited in the California collection at the Paris Exposition of 1878. A roll of sulphur, when rubbed, acquires an odor, becomes electric, and attracts small light bodies, the electricity being negative or resinous. When heated in contact with the air, is oxidized to sulphurous acid (SO_2). Melted and thrown into water it becomes soft and plastic, in which state it is used for taking impressions of coins and the like. It crystallizes from solutions—notably from bisulphide of carbon—and forms prisms. If sulphur is melted in a large vessel and allowed to cool slowly, a crust forms on the outside, this being broken, and the contained liquor poured out, the inner surface of the crust will be found covered with crystals, like the inside of a geode. Sulphur is dimorphous; that is, it will crystallize in two forms or systems under different conditions. When crystallized from fusion, the crystals belong to the fifth system of crystallization; and when from solution, to the third. Natural crystals sometimes form three inches in diameter.

The presence of sulphur may be detected in any substance containing it by heating a small portion of such substance in an open vessel, nearly to redness, when the characteristic odor of the mineral will be observed. If the quantity is small it may be placed in a closed glass tube and heated over an alcohol or gas flame, when the sulphur will sublime and form a ring above the assay. Sulphur in any form can be detected by placing the substance with pure carbonate of soda on charcoal and fusing with the blowpipe. Place the button obtained on a silver coin and wet with water. If sulphur is present a sulphide is formed which, in solution, attacks the silver and turns it black.

Sulphur is soluble in but few fluids. The following table of the principal solvents is compiled from the Dictionary of Chemical Solubilities (Storer):

One hundred parts dissolve of flowers of sulphur parts:	
Bisulphide of carbon, hot	73.46
Bisulphide of carbon, 16° C.	38.70
Rectified coal tar naphtha @ 100° C.	26.98
Benzine, boiling	17.04
Oil of turpentine, 150° C.	16.16
Mineral naphtha, boiling	10.56
Absolute alcohol	.42

The sulphur of commerce is frequently adulterated; mostly with burnt gypsum, flour, earthy substances, arsenic, etc. The presence of these foreign matters can be detected by sublimation.

ITS METALLURGY.

Sulphur is separated from earthy impurities by the following processes: By liquation, by roasting in heaps, by superheated steam, or by solution in bisulphide of carbon. The reader, for a more detailed description of these several processes than is here given, is referred to Lippincott's Encyclopædia of Chemistry, Wagner's Chemical Technology, Ure's Dictionary, and various works on Chemistry and Metallurgy.

By the liquation method, generally practiced in Sicily, the sulphur-bearing material is thrown into circular inclosures of masonry, called "calcaroni," a few faggots having first been placed beneath it to start a fire. After these faggots have been ignited, earth is thrown on the burning pile, which partially prevents the sublimation and oxidation of the sulphur, the draft being so regulated as to maintain a proper degree of heat. A portion of the sulphur is burned, and a portion fusing flows out through an opening prepared for the purpose. From forty to fifty per cent of the mineral is lost by this process, which is best suited for low grade ores. These "calcaroni" are handsomely figured in Science for All, volume 5, folio 197. Where the plan of roasting in heaps is adopted, ores containing the sulphides of iron and copper are disposed of in layers with a certain proportion of wood until a large pyramidal heap is formed, which is then covered with earth, open spaces being left into which the sublimed sulphur may collect. This pile being fired, the roasting is continued for several months, the heat resulting from the decomposition of the ores and the combustion of a portion of the sulphur being sufficient, with the small amount of wood supplied, to keep alive and spread the fire throughout the entire mass. The sublimed sulphur collects in the openings mentioned, from which it is removed several times a day. This process is fully described in Nicholson's Dictionary of Chemistry, published in London, 1795. It was first practiced in the Hartz, in 1570, being the discovery or invention of Christopher Sander.

The plan of manufacturing sulphur by the use of superheated steam has been successfully employed in California and Nevada, and is mentioned in the description given in another part of this article of the works at the Rabbit Hole mines, in the latter State.

Sulphur is also obtained by the distillation of pyrites. By this method the mineral, having been first coarsely powdered, is placed in iron retorts, to which fire being applied, the sulphur separates and melts. It is then drawn off and run into cold water; as no air is admitted the sulphur does not oxidize. In Saxony, where this process is much in use, about ninety pounds of sulphur are produced from one hundred and fifty pounds of the pyrites.

REFINING THE MINERAL.

However sulphur is obtained by first operations, it requires to be refined before it can be employed for any but the most common uses. The refining is effected either by melting in pans, by liquation in iron cylinders, or by distillation from iron retorts or earthen pots. When melted in pans the liquid is poured into wooden molds, forming brimstone or roll sulphur; when powdered, is frequently sold as sublimed sulphur, or flowers of sulphur. In Sicily, the very rich ores are melted in pots set over a fire, the impurities which come to the surface being removed by perforated ladles. When the pot is full the liquid is drawn off and cast into rolls. By liquation the ore is melted in iron cylinders; one portion of the impurities coming to the surface is skimmed off, while another settling to the bottom is left there undisturbed, the liquid between being drawn off in a comparatively pure state. This plan, once common in Sicily, has there been discontinued, having been found both troublesome and wasteful. The other process mentioned is conducted by means of an iron still set in masonry, and connected by a pipe with a brick chamber set some distance away. The sulphur being distilled passes through this pipe into the chamber, which is kept cool, and there sublimes and falls in a powder.

In Anglesea, a form of sublimed sulphur is obtained from pyrites much after the manner above described. Sublimed sulphur is very nearly pure, though the commodity sold as such is sometimes much adulterated. Where this is the case the fraud can be readily detected with the microscope, the genuine consisting of pear-shaped drops easily recognized. Much pulverized sulphur has been sold in San Francisco for the sublimed article.

In October, 1882, experimental works for the manufacture of "flowers of sulphur" by sublimation, were put in operation on Berry Street, San Francisco. The apparatus consisted of a turtle-shaped cast-iron retort set in a furnace, a cast-iron kettle which was placed above the retort, and heated by the waste heat from the retort furnace, and a condensing chamber of brickwork. The sulphur was melted in the kettle, and at intervals run down into the retort through a connecting pipe fitted with a valve which was opened and closed by means of a screw and hand wheel. The raw material was a very inferior article of Japanese sulphur, containing about 20 per cent of impurities. The apparatus was very imperfect, and much trouble and annoyance arose from this cause, but notwithstanding its many defects, some 30 to 40 barrels of a very superior article of sublimed sulphur were produced weekly for a considerable time. Causes extraneous to the business led to its ultimate abandonment, but sufficient was done to prove that it was both practicable and profitable.

SULPHUR PRODUCING LOCALITIES.

Sulphur indications and sulphur springs may be said to be of common occurrence in most of the Pacific States and Territories. But, while such is the case, and while the crude material is known to abound at a few localities, it would be misleading to even repeat the accounts that have come to hand of some of these deposits, so extravagant have they been, both as regards the quantity and the purity of the mineral represented to have been found. In California, this mineral is supposed to occur at the following localities in considerable quantity, though not always under conditions that impart to the deposits any present commercial value: near Clear Lake, in Lake County, and on an elevation known as Chalk Mountain, two miles east of Clear Lake. In the foothills of the Coast Range, thirty miles west from the town of Colusa; in Inyo County, and in the Azuzar Mountains, on the northern border of Santa Barbara and Ventura Counties; also in more limited quantities in Tehama, Napa, Kern, San Luis Obispo, Los Angeles, San Bernardino, and San Diego Counties, the deposits in the last named county, in the vicinity of the Mud Volcanoes, being mentioned in the second report of the State Mineralogist. Commencing in San Luis Obispo County, a sulphur-bearing belt appears at intervals of two to six miles, running through Santa Barbara and Ventura Counties into Los Angeles. Though never worked, nor much explored, these deposits, should they prove rich, will no doubt be utilized hereafter, as they extend through a tolerably well wooded and watered region, and lie convenient to the seacoast.

THE CLEAR LAKE EXPERIMENT.

Only a single enterprise of several undertaken has resulted in the production of any considerable quantity of sulphur in this State, that having been carried on by the California Borax Company, who, singularly enough, starting in to make that salt had their energies diverted to the manufacture of sulphur, and finally ended their career as producers of quicksilver, a business that has since proved more remunerative than either of the others. This company, discovering that the tract of land taken up on the border of Clear Lake for its borate beds contained also large deposits of sulphur, put up, in 1866, works for refining that mineral. These works, which were very complete, having been supplied with iron retorts for steam liquation, receivers, etc., were connected with the sulphur-bearing deposits by a railway 1,300 feet long. They had capacity to make from four to six tons daily, accordingly as the crude material varied in quality. The mineral here is found on an extensively fissured much decomposed solfataric rock, upon which it is deposited by the steam and hot gases that issue from the fissures. It occurs over an area of ten or twelve acres, a little of it being quite pure, though the greater portion is much contaminated with tufaceous debris, the whole averaging not more than eight or ten per cent sulphur. These works, after having been operated with a varying product for six or seven years, were finally closed down, owing to the rate at which the price of sulphur had in the interim declined, the fall having been from $75 to $40 per ton. At no time during this period was the company able to make and deliver in San Francisco a ton of sulphur for less than $35. The chief obstacles to success in this instance consisted in the impossibility of obtaining any large amount of high grade material, and the cost of getting the refined article to market, the latter necessitating wagon transportation for a considerable distance over a rough country.

The production of sulphur made by this company was as follows:

1865	214,650 pounds
1866	675,963 pounds
1867	487,603 pounds
1868	503,481 pounds
Total	1,881,697 pounds

In the manufacture of sulphur at Clear Lake, much of the product was found to be stained a dark color, the cause of which for some time remained a mystery. It appearing at length that this discoloration was due to the presence of mercury in the deposits worked, these were afterwards manipulated for that metal, the property being converted into a quicksilver mine.

THE OTHER CALIFORNIA SULPHUR FINDS

Have, in the light of developments or production made, amounted to but very little. While the foothill beds of Colusa County cover a considerable range, the most of the mineral, some of which occurs on or near the surface, is of low grade, being largely mixed with earthy impurities. A refinery was put up on the spot nearly twenty years ago, but the venture terminated after a short and profitless career; nor has anything been attempted there since. As remarked, the deposits in the Azuzar Mountains remain nearly as nature formed them, which is also the case with the others named.

SULPHUR MINES AND WORKS OF NEVADA.

While so little sulphur has been made in California, a considerable quantity has been produced by the Nevada Company at their mines and works at the locality known as Rabbit Hole Springs, in the State of Nevada. In 1873 a deposit of this mineral was discovered at the above point, which is situated about thirty miles in a northwesterly direction from Humboldt Station, on the Central Pacific Railroad. The sulphur occurs here in lime and magnesian rocks, and in irregular masses, overlaid by a stratum of dry ashy-like earth, which, being removed, the mineral can be broken out in lumps, frequently of large size, and some of it quite pure. In 1876 a single piece of sulphur was taken out here that weighed 1,200 pounds. It was started for the Centennial Exposition, held that year in Philadelphia, but having got broken on the way, never reached its point of destination. These Rabbit Hole deposits are no doubt extensive, being spread over a large area, in bodies of mineral more than one hundred feet in length, and showing an average thickness of twenty by a depth of thirty feet, having been uncovered there.

For working these deposits two companies were formed and proceeded to put up refineries on the ground soon after their discovery. One of these companies proved short lived and the other, though still in existence, has achieved but a moderate success, the cost of getting their product to a market having, as with their predecessors in the field, been the chief obstacle in the way. The expenses of operating at this point have also been great, the country around being dry, barren, and timberless, necessitating the importation of supplies of all kinds. The production made at Rabbit Hole has varied, having amounted some years to a thousand tons or more, while again it has fallen to less than half that amount, the quantity made for the past year or two having been small. This product, the most of it refined sulphur, though some selected lots consisted of native mineral, has nearly all been marketed in San Francisco, having been consumed by the acid works here. A little was also taken by the manufacturers of bluestone at Dayton, Nevada.

The expenditures made by these two companies in supplying plant and making other needed improvements have been considerable, the best refining methods extant having, it is claimed, been introduced into these works. In the method here employed, a modification of the steam process, a cylindrical cast-iron retort about ten feet in height, is provided. Into this, through a trap in the top, the ore is fed, while through a similar aperture, near the bottom, the exhausted charge is withdrawn. Below this last mentioned opening is placed a perforated diaphragm of boiler iron, on which the charge rests. The compartment beneath this plate is bowl shaped and furnished with a pipe for discharging the melted sulphur. When the upper compartment has been filled with ore and the doors securely closed superheated steam is blown in. The sulphur melts and passing through the perforated plate is drawn off as often as required. This apparatus is more fully described in a paper prepared by Mr. D. Van Lennep and published in the *Engineering and Mining Journal*, of New York, October 14, 1882.

Whatever else may be said in explanation of the indifferent success that has thus far attended the efforts of this company, certain it is such result cannot be attributed to any defect in the article turned out by them, the product of their works having been equal to the best offered in the San Francisco market. Their sulphur has, in fact, proved to be as pure as the best French roll brimstone. Nor have manufacturers here, or the trade generally, shown any prejudice against the product of these Nevada mines. On the contrary, they have given it a preference whenever it could be obtained at the same price as the imported article, which latter has undergone a steady decline ever since the manufacture of sulphur was commenced on this coast, and chiefly by reason of such manufacture. The trouble with these Nevada companies, as with most others that have engaged in this business here, has been twofold. First, the great cost of making the sulphur, and second, the cost of getting it to market, the latter alone amounting to nearly twenty dollars per ton. With some improvement in this respect, these companies could, no doubt, make sulphur with profit, as they have the raw material of fair quality in good supply.

Another considerable deposit of sulphur in Nevada is located near that remarkable group of thermals, known as Steamboat Springs, in Washoe County. The mineral occurs here in a belt of light-colored earth, and underlaid with magnesian limestone. It is the product, no doubt, of solfataric action, which is still going on with considerable intensity at this place. The sulphur is found in the above formation in small bunches and strata, some of it quite pure, but the mass largely mixed with earthy matters. These deposits have been exploited by means of shafts, pits, and open trenches, but with such disappointing results, that operations were suspended several years ago, and have not since been resumed, nor are they likely to be very soon, as the mineral can be collected here only at considerable trouble and expense. Deposits of sulphur occur at several other places in this State, notably at a point ten miles north of the Great Humboldt Salt Marsh, also near the Fish Lake borate fields, in Esmeralda County.

CONSUMPTION AND SUPPLY.

The consumption of sulphur on this coast is comparatively large, having amounted lately to about 3,500 tons per annum, the average for more than twenty years past having been at least one half as much. Of the quantity consumed the Judson acid works, in Contra Costa County, and the Golden City acid works, in San Francisco, use up annually about 1,000 tons each, mostly in the manufacture of sulphuric acid; the several smaller works, of which there are four in California and one in Nevada, taking altogether some six or eight hundred tons. The balance of the sulphur used in California, say 600 tons, some being exported, goes to meet the requirements of the vine growers—here considerable—the powder works, the druggists, and the miscellaneous manufacturers.

The supply of sulphur for this coast has, with the exception of that sent from Nevada, been obtained mostly from Sicily, a part having of late years come from Japan. From both of these sources this commodity can, by reason of cheap freights, be laid down in San Francisco at rates that leave the domestic producer little margin for profit. Foreign ships coming to this port to load with wheat bring sulphur at low freight charges, taking it in sometimes for ballast, the same being the case, also, with vessels coming from Japan. Hence the low prices for this article that for a long time past have ruled in the San Francisco market, rendering it difficult for the home to compete with the foreign producer, notwithstanding refined sulphur is subjected to a duty of $10 per ton and flowers of sulphur to a duty of $20 per ton, with 15 per cent ad valorem added; crude sulphur being admitted free. These duties would sufficiently protect the home producer were they actually enforced, which, it is claimed they are not, large quantities of refined being imported under the name of crude sulphur, thereby defrauding the Government of its dues and depriving the home maker of the protection it was intended he should enjoy.

While the imports of sulphur at San Francisco have been considerable, exports have been trifling, consisting of thirty-five or forty tons sent yearly to Mexico, and still less to other of our neighbors. The price in this city has not for the past ten years exceeded $45 per ton. For several years past it has ruled at about $35, being just now somewhat less.

IN THE EASTWARD LYING TERRITORIES AND OLDER STATES.

Outside of Nevada there is very little sulphur made anywhere in the United States, although deposits of this mineral are reported to occur abundantly in Utah, Wyoming, Montana, and New Mexico; also more sparsely in Louisiana and Virginia. Sulphuric acid is, however, manufactured to a greater or less extent in nearly all the older States of the Union, New Jersey, Pennsylvania, Maryland, New York, and Ohio being the largest producers of this commodity, which is made principally from crude Sicilian sulphur imported for the purpose, duty free, some being also made from pyrites. The imports of Sicilian sulphur into the United States have increased from 27,596 tons, valued at $765,024, in 1872, to 101,595 tons, valued at $2,674,449, in 1882. Albert Williams, in his recent work expresses the opinion that the manufacture of sulphuric acid will grow into a very important industry in some of the older States, and that possibly most of this acid will in time come to be made from pyrites, as supplying a cheaper material for the purpose than brimstone.

CRUDE SULPHUR OR BRIMSTONE IMPORTED INTO THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED—SPECIE VALUES. (FREE OF DUTY.)

Years.	Tons.	Value.	Years.	Tons.	Value.
1872	27,596	$765,024	1878	47,922	$1,173,156
1873	45,340	1,300,626	1879	65,919	1,487,698
1874	41,539	1,260,140	1880	83,236	1,927,502
1875	39,584	1,255,100	1881	105,438	2,713,494
1876	48,966	1,473,678	1882	97,956	2,627,402
1877	43,443	1,242,788	Calendar year 1882	101,595	2,674,449

REFINED SULPHUR IMPORTED INTO THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED—SPECIE VALUES. (DUTIABLE.)

Years.	Cwts.	Value.	Years.	Cwts.	Value.
1872	2,027	$4,795	1878	6,628	$14,924
1873	2,117	5,180	1879	5,126	10,963
1874	1,709	4,129	1880	3,180	5,530
1875	535	1,399	1881	3,072	6,121
1876	2,375	5,668	1882	7,891	15,651
1877	29,039	48,868	Calendar year 1882	6,895	13,578

SULPHUR EXPORTED FROM THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED.

Years.	Crude.		Refined.		Years.	Crude.		Refined.	
	Tons.	Value.	Cwts.	Value.		Tons.	Value.	Cwts.	Value.
1872	------	------	103	$270	1878	------	------	------	------
1873	5	$362	224	1,062	1879	------	------	39	$98
1874	------	------	------	------	1880	------	------	94	221
1875	------	------	130	344	1881	------	------	------	------
1876	------	------	------	------	1882	------	------	587	1,221
1877	------	------	1,086	2,688	Calendar year 1882	------	------	979	1,973

Some idea of the magnitude of the sulphur trade in Europe may be gained from the following figures: In 1868, 453,824,000 pounds of sulphur were imported into England from Sicily. In 1870, the total production of Europe was 785,400,000 pounds, not including that recovered from soda waste. The yearly imports of sulphur into England from Spain, Germany, and Norway is very great. One author estimates it at 1,000,000 tons. This is probably a mistake.

SULPHURETS AND SULPHURET OF IRON—see Pyrite.

SULPHURET OF SILVER—see Argentite.

144. SYLVANITE. Etym. *Transylvania.* Telluride of Gold.

This rare mineral is said to exist in the Melones and Stanislaus mines, with other tellurium minerals.

145. TALC. Steatite, Soapstone, French Chalk.

This is a soft mineral, generally foliated, except where it occurs in rocky masses as soapstone, when it is granular or crypto-crystalline. When pure it is of a green, white, or yellowish color, with a greasy or soapy feel. H.=1—2.5. Sp. gr.=2.55—2.78. It is practically infusible, and is not decomposed by acids. It is usually found associated with serpentine, chlorite, and talcose schists, and forms an important constituent in some rocks. Talc is a hydrous silicate of magnesia and iron, sometimes containing alumina and other bases. Talc schist is an aggregation of scaly talc, with, frequently, quartz, feldspar, magnetite, mica, and other minerals. The massive variety of talc (soapstone) is used as a fire-resisting material, in place of brick, for lining stoves and furnaces. It is easily sawed into the forms required, and answers the purpose when the greatest extremes of heat are not used. The fine-grained talc is used for marking on cloth by tailors, and for dusting into tight shoes and gloves. It is used to some extent as an anti-friction material, and in the manufacture of paper. A fine crystalline variety, from Lower California, is used in the manufacture of paper hangings to give a silky gloss to the surface.

Steatite has been employed here to some extent in the manufacture of an infusible felting, and a fireproof paint, for which uses it is well adapted. This felting is applied to steam boilers and pipes, and being a non-conductor of heat, saves much fuel. As this mineral is abundant; and can be employed for a variety of purposes other than the above, it will, no doubt, come gradually into larger use. About 30,000 tons of talc are mined annually in the Eastern States, worth at the mines $12 per ton. This mineral is imported into the United States from Italy, Austria, and France, to the value of about $21,000 per year.

Talc is in considerable demand in Europe, as will be seen by the following extract:

LONDON, March 11, 1884.

To the Editor of the Mining Record:

SIR: It may be of interest to some of your readers to know that lump talc, or soapstone, is wanted in this country, and we understand it is to be obtained in North Carolina; there may be some elsewhere; free from veins; it should be free from iron, also in a firm state. Hoping you will consider this worthy of insertion.

O'HARA & HOAR,
Mineral Merchants, 12 Lime Street.

Soapstone occurs in numerous localities in the State. At the Alabaster lime quarry, Placer County, soapstone found near by, is used for lining the furnaces, and proves to be very refractory. There seems to be no reason why it should not wholly replace the costly imported fire-brick formerly used. I am informed by Mr. C. P. Dubois, Superintendent, that soapstone is used successfully in the furnaces at the Julian and Alabama mines, in the above county. The works of the Stockbridge Soapstone Quarry Company lie in Section ——, Township 15 north, Range 9 east, half a mile from Long Ravine toll gate, about nine miles southeast from Grass Valley, and within a quarter of a mile of the Colfax and Nevada City Narrow Gauge Railroad. This deposit was formerly worked for gold, which it contains in small quantities. The talc was crushed under edge wheels of cast iron, running in a bed of iron plates, at the rate of thirty-five tons per day. Owing to defective manipulation, or the peculiar nature of the material worked, the results were so unsatisfactory that milling for gold was discontinued. It was then worked for soapstone with somewhat better success. The stone, which seems to be of good quality, is cut with circular saws into slabs and brick-shaped blocks, which have given satisfaction as a fire-proof material. Twenty thousand bricks have been sold at fifty dollars per thousand, but, owing to high freight and limited market, the manufacture has been from time to time suspended. At the time of my visit, Charles Leech, of Grass Valley, was proprietor, and Frank Herrold, of Colfax, manager. The quarry is worked by an open cut, one hundred and ninety feet above the mill; the incline is steep, but is overcome by a tramway, on which two cars run. The following localities are represented in the State Museum:

(172,) soapstone, Placer County; (352,) talc, seven miles from Mount Hamilton, Santa Clara County; (2276,) talc in quartz, Yosemite gold mine, Mariposa County; (578,) Yuba County; (908,) eight feet thick, Tuolumne County; (1443,) fourteen miles below San Pedro, Los Angeles County, on the coast; (1459,) wall rock, Maryland mine, Grass Valley, Nevada County; (1654,) Fresno County; (1685,) soapstone, two miles northeast of Jackson, Amador County; (1864,) soapstone, Stockbridge Soapstone Works, near Colfax, Placer County; (2050,) Taylorville, Paper Mill Creek, Marin County; (2270,) Soapstone Mountain, Kern County; (2366,) soapstone, Tule River, Tulare County; (3644,) cut in the form of bricks and the same size, of good quality, and suitable to be used as a substitute for fire bricks, Lewis, Mariposa County; (3724,) talc, much resembling French chalk, Pine Flat, Sonoma County;

(4247,) talc foliated, with chalcopyrite, San Diego County; (4472,) near Murphy's, Calaveras County; it is also found at Rocky Hill and Jenny Lind Hill (Trask); Rock Island Hill, Plumas County (Edman); and near Lone Pine, Alabama Range, Inyo County, is found a peculiar greenish, semi-translucent variety, not exactly like soapstone, but micaceous feeling (Aaron).

TCHERMIGNITE—see Alum.

TELLURIC GOLD—see Sylvanite.

TELLURIDE OF SILVER—see Hessite.

146. TELLURIUM—see also Altaite, Calaverite, Hessite, Petzite, and Tetradymite.

Tellurium is a white metal, brittle, and easily fusible. Its equivalent or combining weight is 64.2 in the old system of notation, which is doubled in the new. The symbol used by chemists to express this element is (Te).

Tellurium was discovered and named by Klaproth. The specific gravity of the metal is 6.257. The name tellurium is derived from the Latin word "*Tellus*," the earth. The word "telluric" has no reference to the metal, but implies, pertaining to the earth.

This metal is very rare on the earth, but exists in a gaseous state, probably combined with hydrogen, in the atmosphere of some of the fixed stars, as revealed by the spectroscope. It is particularly noticeable in Aldebaran. I think I am not mistaken in stating that it has not yet been discovered in the sun.

Tellurium, as far as known, is found only in ten rare minerals, as follows (the figures showing the percentage of tellurium in each):

1. ALTAITE, combined with lead	38.2
2. CALAVERITE, combined with gold and silver	56.0
3. HESSITE, combined with silver	37.2
4. JOSEITE, combined with sulphur, selenium, and bismuth	15.93
5. Nagyagite, combined with sulphur, lead, silver, gold, and copper	30.52
6. PETZITE, a variety of hessite (No. 3)	
7. SYLVANITE, combined with antimony, gold, silver, and lead	44 to 60
8. Tellurium, native, nearly pure	
9. TETRADYMITE, combined with silver and bismuth	33 to 48
10. Tellurite, doubtful	

Those in capitals have been found in the State.

Tellurium is not only fusible, but is volatile, and may be sublimed in a glass tube without change. When exposed to high temperatures it becomes oxidized to tellurous acid ($Te\ O_2$), giving off dense white vapors. If the experiment is made in a piece of clean charcoal before the blowpipe flame, a coating is formed on the coal. If this coating is touched by the point of the reducing flame, it disappears, tinging the flame at the same time bluish-green. This reaction is characteristic. Any substance containing tellurium imparts a red color to boiling concentrated sulphuric acid. By these tests tellurium may be detected with certainty in any substance which may contain it.

The statement lately made in the papers, that a firm in San Francisco had paid $3,000 for one pound of tellurium, is evidently a mistake. At the rate of 51 cents per gram—at which price it is quoted in German price lists—a pound would only be worth $231 54. But when it is known that dealers make large discounts on their printed list of prices, and that wholesale rates are much less than retail, it is evident that so large a quantity as a pound could be bought for a much less sum.

Tellurium has absolutely no use in the arts. It is only prepared in small quantities as a chemical curiosity. All the reactions of the metal can be obtained by students from some of the minerals containing it, which are comparatively cheap. Like every other manufacture, its production is governed by the laws of supply and demand. In this case both the supply and demand are small; hence there is no inducement for its production, and those who do produce it naturally realize all they can from their small sales.

As an illustration of how the price of a commodity decreases when inducements are offered for its large manufacture, I have only to cite the metal sodium, which, a few years ago, was very high-priced for the same reason that tellurium is at the present time, although the supply was enormous, the dispersion of sodium being greater than that of almost any other substance. When the demand increased—it being required for the manufacture of sodium amalgam, and for the reduction of aluminum—new methods of producing it were discovered, and it has now become quite cheap and abundant.

Tellurium is found in considerable quantities in Schemnitz, Hungary, and in the silver mine of Sadovinski, in the Altai, associated with silver and lead. At the mine "Maria Loretto," in Transylvania, in sandstone, with quartz, pyrites, and gold. From this locality (Transylvania) the name "sylvanite" is derived. In the United States it has been discovered in Virginia and North Carolina associated with bismuth (tetradymite). Fine specimens come to us from the American mine, Sunshine District, Bowlder County, Colorado. In our own State it is not rare, being found in considerable quantities in several localities. The Melones mine, Calaveras County, is a celebrated locality. Splendid specimens of calaverite, hessite, sylvanite, and native tellurium associated with gold, have been shown in this city.

Metallic tellurium is principally obtained from the telluride of bismuth (tetradymite). The ore is first washed to concentrate it, then mixed with an equal weight of carbonate of soda or potash. The mixture is then made into a paste with olive oil, and heated in a closed crucible, first gently, to prevent frothing, then at a high heat. The fused mass is digested in water, which dissolves out the telluride of soda or potash, giving a deep wine colored solution. The bismuth and the charcoal resulting from the burning of the oil remain behind. If the liquid is allowed to stand exposed to the air, the tellurium gradually precipitates until it has all separated. This precipitation can be greatly accelerated by blowing air through the solution. The precipitated metal is purified by washing in dilute acid and distilling in an atmosphere of hydrogen.

The following letter contains a great deal of information concerning the tellurium minerals in California:

Palace Hotel, San Francisco, March 8, 1884.

Henry G. Hanks, San Francisco, Cal.:

Dear Sir: In answer to your question respecting the localities where tellurium is found in California, I can say that I have seen it in considerable quantities in Mariposa County, especially on the Merced River, not far from the Marble Spring mine. I have heard of it in the ores of the Mariposa Company and seen specimens said to have come from that property. Following the western branch of the mother vein, north, tellurium is found in large quantities in the Rawhide mine, near Chinese Camp, and in many mines around Tuttletown. Crossing the Stanislaus River, at Robinson's ferry, tellurium is found in masses, accompanied with massive gold, in the Stanislaus mine, and as telluride of lead in the Adalaide mine. In the Morgan mine, it appears as calaverite, petzite, and sylvanite, accompanied by gold in large masses; also, telluride of lead carrying gold. All the mines on Carson Hill and Chaparral Hill, where the Morgan mine is situated, have ores more or less associated with tellurium or tellurium compounds. I have heard of tellurium in Placer County, and I have seen it in Nevada, Butte, and Sierra Counties. In Sierra County, in the Oriental mine, very fine ores of tellurium are found associated with free gold and arsenical pyrites rich in gold. In the Murchie mine, Nevada County, very fine tellurides are found, and also in many mines on Feather River.

Ores of tellurium are difficult to work. In the raw way this mineral is detrimental to and sometimes utterly prevents amalgamation. It is volatile and disappears in roasting, carrying the gold with it, unless the greatest care is taken.

In *all* cases that have so far come under my observation the ores containing tellurium are very rich in gold, the tellurium invariably being rich in precious metals. In Bowlder County, Colorado, I have seen a compound of lead and tellurium, but in California I have never seen a simple compound of this sort—gold is always a factor and generally silver also.

Higher up in the mountains selenium is found also associated with gold. At the Oro Plata mine, in Murphy's, Calaveras County, seven miles from Carson Hill, compounds of selenium, gold, and copper are found. The mineral here is not massive, but exists in segregated crystals, very minute. The per cent of mineral in the ore is rarely over one half of one per cent and generally less than one eighth of one per cent, but the concentrates of this mineral are worth from $4,000 to $8,000 per ton. I have tested tellurium worth from $40,000 to $80,000 a ton from the various mines I have mentioned. I have an idea that tellurium accompanies the western branch of the mother vein throughout the State. I believe when more attention is paid to the refractory ores of California that tellurium and selenium will be found very valuable additions to the gold-bearing rocks of the State and worthy special study.

Very truly yours, Z. A. WILLARD.

147. TETRADYMITE. Etym. *Quadruple* (Greek). Bismuth, with Tellurium.

Professor Blake discovered a tellurium mineral in the Melones mine, Calaveras County, which he thought might be tetradymite, associated with gold. According to Willard, it occurs with massive gold in the Morgan mine, Carson Hill, and in the Melones mine, Calaveras County. It is said, also, to be found in the Murchie mine, Nevada County.

148. TETRAHEDRITE. Gray Copper, Fahlerz.

This mineral is a double sulphide of copper and antimony, of which there are numerous varieties. It is found in Mariposa County, with the gold in the Pine Tree vein; also with the gold in the same or similar vein at the Crown lode, Emily Peak, and at Coulterville, in several claims; in Calaveras County, at Carson Hill, in the large vein, and associated with gold. This ore, in decomposing, leaves a blue stain of carbonate in the quartz, and where it is found the rock is generally rich in gold (Blake). It is also found in the Golden Rule mine, Tuolumne County (Dana); in the White Mountain, Inyo County (Aaron); with barite and sulphur, both crystallized, in the Irby Holt mine, Indian Valley, Plumas County; and in the Jacob's Wonder mine, Panamint, Inyo County.

149. THENARDITE. Etym. *Thenard*, French chemist. Anhydrous Sulphate of Soda. ($Na\ O, SO_3$.)

Soda	56.3
Sulphuric acid	43.7
	100.0

This mineral dissolves in water, from which it may be obtained by crystallization in magnificent needle shaped crystals of hydrated sulphate of soda, which effloresce and fall to a white amorphous alkaline powder if left exposed to the air. When wet with hydrochloric acid and alcohol, and ignited, a golden yellow flame is obtained. It is found in great abundance in California and Nevada, with salt, ulexite, and borax, in beds of considerable thickness, resembling ice, which it is called by the borax workmen. Frequently the tincal crystals are imbedded in it, and are separated by solution in water. The thenardite being the most soluble, the crystals of tincal are set free and removed by perforated ladles. Considerable borax is lost in the operation, but it is still found to be economical. Sulphate of soda is the material required for the manufacture of carbonate and caustic soda. The first operation in the Le Blanc process is to form sulphate of soda by heating together salt and sulphuric acid in iron retorts. Sulphate of soda is formed, while hydrochloric acid gas is driven off by the heat employed, and condensed in water. The calcined sulphate is then heated with carbonate of lime and coal slack in a reverberatory furnace, forming "black ash," which is lixiviated and boiled down in iron pans to "soda ash," in which form it is commonly sold. This salt may be dissolved and crystallized to obtain "soda crystals;" or the solution heated with caustic lime, which precipitates the carbonic acid and leaves the solution "caustic." It is then evaporated to dryness, fused, and cast into sheet-iron drums, and is used for soap making and other purposes. This process is costly as to plant and waste in the first operation, viz.: the production of the crude sulphate of soda. Here, nature has produced it, and eventually it will be utilized in the manufacture of soda. Being anhydrous, thenardite would cost less for transportation, as there is no water of crystallization to pay freight on. Thenardite is said to exist in very large quantities at the works of the San Bernardino Borax Company. For further particulars, see third annual report of State Mineralogist, 1883.

Thinolite—see Calcite.

Tin—see Cassiterite.

Tincal—see Borax.

150. TITANITE. Sphene, Titaniferous Iron. Named from Titanium, one of the elements. Sphene is from the Greek for a wedge, from the shape of its crystals.

Titaniferous iron is found in iron sand in Spanish Creek, Plumas County (Edman). Sphene is found in small hair form crystals in the granite of the Sierra Nevada (Blake).

151. TOURMALINE.

Is a mineral almost invariably found crystallized, of all colors, from opaque black to nearly or quite transparent colorless. The usual colors are: *black* (schorl), *red* (rubellite), *blue* (indicolite), *green* (crysolite), *honey-yellow* (peridot), *colorless* (achroite).

All the tourmalines contain boracic acid from three to ten per cent. This mineral has never been worked for boracic acid, but is probably a source of that acid in nature, resulting from the decomposition of rocks containing it. The following analysis, selected from many, is given as an example of the general composition of tourmaline:

Silica	36.71
Boracic acid	6.49
Alumina	36.00
Binoxide of manganese	6.14
Sesquioxide iron	7.14
Magnesia	2.30
Lime	.80
Soda	2.04
Potash	.38
Fluorine	2.00
	100.00

Rubellite—Rose-colored Tourmaline.—This very interesting mineral is now observed for the first time in California, in the form of long slender crystals from one sixteenth to one eighth of an inch in transverse diameter, with the usual triangular section. Color, a beautiful rose pink, contrasting well with the matrix of white lepidolite. When ignited the color disappears and the mineral becomes perfectly white. Infusible. Locality, San Bernardino Range, Southern California (Blake).

Schorl.—San Diego County, north side of the valley of San Felipe, in feldspathic veins (for description and figure see Rep. Geol. Rec. Cal., Blake, p. 304). Tuolumne County, large crystals are found in granite on the summits of the Sierras. In white quartz, Calaveras County; and in Contra Costa County, near the Bay of San Francisco; and in San Diego County, from whence a fine crystal was brought to San Francisco by Capt. Woodley. Tourmaline is named from "Turmalin" from "Turamali," the native name given to this mineral in Ceylon, from whence it was brought to Holland in 1703. Rubellite is derived from the Latin, *rubellus*, a diminutive of *ruber* (red).

TRAVERTINE—see Calcite.

TREMOLITE—see Amphibole.

152. TRONA. Etym. Egyptian name. Sesquicarbonate of Soda. $(2NaO, 3CO_2+4HO.)$

Soda	37.8
Carbonic acid	40.2
Water	22.0
	100.0

This mineral is found with salt, thenardite, tincal, and gay-lussite, at the works of the San Bernardino Borax Company, and is utilized to some extent in the manufacture of borax. It is also found in Death Valley, Inyo County, and at other localities in the Mojave and Colorado deserts.

The extraordinary deposit of carbonate of soda near Ragtown, in the State of Nevada, has obviated the necessity of our looking to any other source for a present supply of the crude material, which can there be obtained in almost unlimited quantity and at very little cost. On removing a few feet of top soil the soda is found here in a solid mass extending to an undetermined depth. The deposit, over an area of several acres, has been opened downward for a distance of forty feet without showing any signs of exhaustion in that direction, nor have its exterior limits yet been reached on every side. This deposit is worked after the manner of an open quarry, large blocks of the nearly pure soda being broken out and removed to the banks of the pit, where they are left turned up on one edge until the water drains off, after which they are ready to be shipped to market.

This material, after being refined, is used chiefly for the manufacture of baking powder and washing powder, soda ash, washing crystals, etc. In making baking or yeast powder the soda is first converted into a bicarbonate.

The following is an analysis of this Nevada soda, by C. S. Rodman:

Carbonic acid	38.70
Soda	39.97
Water	19.42
Salt	1.88
Sulphate of soda	.39
Silica	.13
	100.49

The only extensive works on this coast engaged in the business of refining carbonate of soda and manufacturing it, is that of John Horstmann, situate on Bryant Street, in this city. For making baking powder, the English soda is employed; for all other purposes, the Nevada is used. Mr. Horstmann buys of this material about five hundred tons per year, he being the only large consumer of it in San Francisco. It costs, delivered here, an average of $45 per ton. The Nevada soda would answer for making baking powder equally as well as the English, were proper care observed in refining it. For all other purposes it is equal to the imported.

Mr. Horstmann reports such an increase of business as necessitates an immediate enlargement of his present works, it being his intention to now engage in the manufacture of soda ash and some other commodities not heretofore produced by him. But, notwithstanding such industry, our importations of the bicarbonate of soda from Great Britain increased from 549,950 pounds, in 1882, to 1,798,462 pounds, in 1883; there occurred, however, a heavy falling off meantime of our imports of soda ash and caustic soda from that quarter.

Tufa—see Calcite and Aragonite.

153. TURBITH MINERAL. Yellow Sulphate of Mercury.

Is not found in nature. Specimens taken from the interior of the furnaces at the Sulphur Bank quicksilver mine, Lake County, were exhibited by T. Parrott at the Paris Exposition of 1878, and at his request were delivered to the School of Mines, Paris, at the close of the Exposition.

154. ULEXITE. Borate of Lime, Tiza, Boronatrocalcite, Natroborocalcite, Tinkalzit, Cotton Balls, Sheet Cotton, etc.

Ulexite is a natural hydrated borate of lime and soda. This curious mineral was first found in the niter beds of Peru in small quantities, in small globular concretions, showing when broken interlaced, silky-white crystals; sometimes also inclosed crystals of salt or gypsum.

It was examined by Ulex. His analysis of a specimen from Iquique, Southern Peru, gave:

Boracic acid	49.5
Lime	15.9
Soda	8.8
Water	25.8
	100.0

The mineral was afterwards analyzed by A. A. Hayes, who proposed the formula ($CaO, 2\ BO_3+6HO$). He supposed the soda found by Ulex to result from mechanically mixed glauberite. For some time this mineral was called "Hayesene;" but Dana, in the last edition of his work on mineralogy, gives it the name of Ulexite, in justice to the first observer.

The following extracts from "Mineraux du Pérou," by A. Raimondi, Paris, 1878, seem to show the analysis of Hayes to have been a mistake.

Ulexite was first found in the Province of Tarapaca, then named Borax or Tiza—lately found in the Cordillere de Maricunga, at an altitude of 3,800 meters (12,464 feet). Mr. Raimondi calls attention to a widespread error found in works on mineralogy, as to a borate of lime without soda, under the name of Hayasene, which, in his opinion, does not exist in Peru. In 1853, while in the employ of the Government of Peru, he visited all the known localities of the borates in the Province of Tarapaca. He examined a large number of specimens, and made a great number of excavations, and his conclusions were that the sample of borate of lime called Hayesene was Ulexite, or Boronatrocalcite. Ulexite was found for the first time in 1836-7, in Tarapaca, forty or fifty kilometers from Iquique, under the crust that covers the nitrate of soda beds, nearly always in little rounded masses from the size of a hazelnut up to that of a large potato—color white, fibrous, and silky. Very often the balls of ulexite have in their interior a nucleus of glauberite. The first notice in the scientific press is found in the second edition of the mineralogy of Dana, 1844, page 243, in which the author says that he had received a communication from Mr. Hayes, descriptive of a new mineral, under the name of borate of lime (*borocalcius obliquus*):

I repeat here what I have already said, that I am thoroughly convinced that the mineral described by Mr. Hayes as presenting rounded masses showing fibrous, white, silky crystals frequently accompanied by glauberite, is borate of lime and soda, and not simple borate of lime.

The many analyses which I made of all the specimens collected while Commissioner to the Government of Peru in 1853; and the analysis made in 1855 by the distinguished chemist Rammelsberg, of the material which presented all the physical characters of the doubtful Hayesene, establish in a manner nearly certain that in Peru there exists only a single combination of boric acid with lime, and that the combination is a double borate of lime and soda, described in works on mineralogy, under the name of ulexite or boronatrocalcite.

To complete what I have said on this important mineral, I give the composition of three specimens of boronatrocalcite found in a state of great purity in a very dry earth in the Province of Tarapaca, which appear in the report that I presented to the Peruvian Government in 1854.

These results agree with those obtained by Rammelsberg, only the specimens analyzed by the latter were not pure, because the boronatrocalcite was mixed with a small quantity of chloride of sodium and sulphate of soda and lime.

ANALYSIS OF ULEXITE, OR BORONATROCALCITE.

Substance Found.	By A. Raimondi.			By Rammelsberg.
	(1)	(2)	(3)	
Boracic acid	42.98	43.13	43.04	42.12
Lime	13.94	14.14	14.06	12.46
Soda	6.96	6.92	7.05	6.52
Water	36.80	35.75	35.85	34.40
Chloride of potassium	----	----	----	1.26
Chloride of sodium	0.16	Traces.	Traces.	1.66
Sulphate of soda	0.12	Traces.	Traces.	0.81
Sulphate of lime	----	----	----	0.77
Total	100.96	99.94	100.00	100.00

Notwithstanding the fact that Mr. Raimondi failed to find hayesene; there seems to be such a mineral, *a hydrous borate of lime, without soda.* Mr. N. H. Darton (American Journal of Science, 1882,) describes a mineral from Bergen Hill, New Jersey, to which he gives the name of hayesene, which had the following composition:

Lime	18.39
Boracic acid	46.10
Water	35.46
	99.95

Soda, silica, and magnesia, traces.

Ulexite is found at a number of localities on the Pacific Coast. It occurs in rounded concretions, from the size of peas to masses ten or twelve inches in diameter. Unless the so called cotton balls are carefully selected by hand, the percentage is greatly reduced by the admixture of sand, worthless soluble salts, and water. Much disappointment has been experienced from this cause. Shipments have rarely failed to be much lower grade than was expected.

As early as 1871, in the examination of ulexite and impure borates from the then newly discovered Columbus marsh borax fields, I accidentally discovered that very impure borate of lime in the cotton ball form could be concentrated and purified by very simple mechanical means, which information was given to the public in a report to the Nevada Consolidated Borax Company, November 11, 1871, in the following words:

Crude borate of lime can be easily and cheaply concentrated by simple mechanical treatment with cold water, in which it is nearly insoluble. A large vat should be constructed, in which the crude material is to be placed with a quantity of cold water. The contents of the vat must be kept in slow agitation by the proper machinery, until the borate of lime has been reduced to a pulpy form, and all mechanical impurity has settled to the bottom. When these conditions are fulfilled, a plug is withdrawn, and the contents of the tub allowed to run into a settling vat. Care must be taken not to allow the sand and other impurity to flow out with the purified borate of lime. In the settler, the borate of lime will soon fall to the bottom, and the clear portion contains biborate of soda (if that salt was associated with the borate of lime); which may be recovered by proper crystallization.

The purified ulexite may then be thrown on an inclined platform and allowed to drain, and then be dried in the sun.

The borate of lime so purified should have nearly the composition of the best natural product.

As borate of lime is quite voluminous in this condition, it should be compressed by powerful screws into a smaller bulk, as crude cotton is treated for the same reason. Ulexite containing twenty-four per cent of boracic acid has a market value in London of £18 per ton of 2,240 pounds.

There is a variety of ulexite called *sheet cotton* by the prospectors, which is sometimes quite overlooked. It is granular in appearance, but under the microscope it is seen to be ulexite in minute silky crystals. There is a specimen in the State Museum (No. 3590) which shows both varieties. Ten tons of boracic acid was made from this substance at the Phœnix Chemical Works at Columbus, Esmeralda County, Nevada, of which Mr. H. S. Durden was Superintendent. A sample of this acid (No. 3591) may also be seen in the State Museum. The following mechanical analyses of crude ulexite show the nature of the impurities:

No. 1.

Sand	9.25
Water hygroscopic	21.00
Soluble salts, mostly sulphate of soda and salt	17.36
Borate of lime	52.39
	100.00

No. 2.

Sand	Trace
Water	36.80
Soluble salts	11.04
Borate of lime	52.16
	100.00

The history of the discovery of ulexite in Nevada is given in detail in the third annual report. I have since gained the following information as to how the first specimen obtained came to be known as a valuable mineral:

In 1864 Albert Mack went to the newly discovered mines at Columbus, with George Daugherty, and in digging for water found the sample of borate of lime mentioned (third report, fol. 45), which he, for determination, presented to Dr. Partz, at Partzwick, Mono County.

Since the third report was published considerable borate of lime has been shipped to Europe, and some has been worked, from Borax Lake, near Grapevine Cañon, Kern County. The following is from the *Reno Gazette*, September 20, 1883:

Borate of Lime.—Nine carloads of borate of lime came in from Rhode's Marsh on the C. and C. by the V. and T. noon train to-day, consigned to Port Costa, California, where a ship is waiting to receive it for transportation to some foreign country.

The following localities of ulexite are represented in the State Museum: (4956), the variety technically known as "sheet cotton," containing free boracic acid, from Death Valley, Inyo County; (4957), borax made from it by decomposing it with carbonate of soda; (5291, 5292), are "sheet cotton" from Desert Springs Lake, Kern County, and (5293), boracic acid made from it by the Boracic Acid Manufacturing Company, J. B. Hobson, Superintendent.

Variegated Copper Ore—see Bornite.

155. VESUVIANITE. Etym. *Vesuvius*. Idocrase.

Is a silicate of alumina, lime, iron, etc., first found in the ancient lavas of Vesuvius, whence the name. It has been found in the Siegel Lode, El Dorado County (Blake). Some years ago, Mr. S. S. Taylor sent a fine specimen to San Francisco, from Spanish Ranch, California.

Vitreous Copper—see Chalcosite.

Vitreous Silver—see Argentite.

156. VIVIANITE.

Among a set of samples from Brea Ranch, Los Angeles County, sent recently to the State Mining Bureau, by Mr. J. W. Redway, of Los Angeles, was one of dark color and earthy texture, containing small nodular masses of a beautiful pale blue color, which were examined and found to be vivianite, or hydrous phosphate of iron. This mineral, which is rare in California, is interesting as leading to the hope that other phosphates, so important as fertilizers, may be found at or near the new locality. There is a specimen of vivianite in the museum of the State University, which is said to be from a California locality, but, if my memory serves me, this is attended with some doubt. It is reported also at Young's Hill, Yuba County, and near Oroville, Butte County, but no certain information has been obtained. The Los Angeles mineral occurs with asphaltum at the well known Brea Ranch deposit. The specimen is marked, "Gangue and Country Rock." The mass is a dark colored earthy mineral, with streaks and veins of asphaltic substance, the whole being evidently the sandy desert soil blown over liquid asphaltum and cemented by it. The vivianite is in small inclosed nodules, never larger than a pea, and generally smaller. The mineral is that variety known as blue iron earth or native Prussian blue. It is soft, pulverulent; under the microscope, crypto-crystalline; before the blowpipe, whitens for an instant, then blackens and fuses to a black magnetic globule. It is wholly and easily decomposed, by boiling hydrochloric acid; the solution reacts for iron, which, being separated, the solution gives precipitates with sulphate of magnesia and with molybdate of ammonia. In a closed tube it gives much water. The specimen has been numbered 3538, and placed in the State Museum, where it may be seen. The name vivianite was given to this mineral by Werner, after an English mineralogist, J. G. Vivian, who discovered it in Cornwall. When pure, it has the following composition, as given by Dana:

Phosphoric acid	28.30
Protoxide of iron	43.00
Water	28.70
	100.00

Wood Opal—see Opal and Quartz.

Wood Tin—see Cassiterite.

157. WULFENITE. Molybdate of Lead.

This mineral is found as yet but sparingly in California, although it is abundant in Nevada and Arizona. It is represented in the State Museum by No. 5351, as small, perfect, tabular crystals, in ore from a mineral vein containing other lead minerals, six miles northeast of Cave Springs, Kern County. In Owens' River Valley, Inyo County, the miners are often vexed by finding a heavy yellow mineral in the pan or horn spoon, mixed with the gold prospect, which so much resembles the noble metal that they are frequently deceived by it. It is probably molybdate of lead, the specific gravity of which is from 6 to 7.

YELLOW COPPER ORE—see Chalcopyrite.

YELLOW OCHRE—see Limonite.

158. ZARATITE. Emerald Nickel, Hydrate of Nickel, Hydrated Carbonate of Nickel.

A rare mineral and ore that is never found in large quantities, generally as a thin coating on chromic iron and serpentine. It was observed by Blake on chrome iron in Monterey County. Dr. Trask reported it also with chrome iron at Panoches, Gabilan Mountains; Cañada of San Benito; and in Alameda County.

159. ZEOLITE. Etym. *Boil* and *Stone* (Greek).

The name zeolite applies to a group of minerals which includes at least twenty species; the name is therefore indefinite. They are all hydrous silicates of alumina, and generally are found in lavas and amygdaloids. There are several minerals in the State Museum from California which have been provisionally referred to the zeolites, pending future analysis and determination: (4155), in lava, North Fork mining district, Fresno County; (4214), in lava, Eureka, Humboldt County; (5084), in cellular lava, Soledad Cañon, Los Angeles County.

160. ZINC. See also Blende, Sphalerite, and Smithsonite.

Zinc is a metal of rather rare occurrence, never found in nature in a metallic state. Sp. gr.=6.861; atomic weight, 32.56 by old, and 65 by new system. The color of zinc is blue-white; it takes, when polished, a bright luster; fuses at 260 C. and boils at a white heat. With copper, it forms brass, one of the most useful and universal alloys. Zinc ores were known to the ancients under the names Calamine or Cadmia. The metal was not known to them, but brass was made by melting the ores of zinc and copper together. It is found in nature as sulphide (blende, or sphalerite), carbonate (smithsonite), and silicate (calamine), rarely combined with other elements or compounds. It is recovered from its ore by dry distillation, or sublimation. It is quite abundant in California, as sphalerite, or blende (which see). Oxide of zinc is extensively used under the name of zinc white as a pigment. The sulphate (white vitriol), is a powerful disinfectant.

161. ZIRCON. Jargon, Silicate of Zirconia (ZrO_2 SiO_2).

Silica	33
Zirconia	67
	100

H=7.5; sp. gr.=4.05—4.75; luster, adamantine; colorless, pale yellow, green, brown; transparent, opaque. It occurs in crystalline rocks; when these rocks decompose the extreme hardness of the zircon protects it against disintegration, and its specific gravity causes it to sink through loose formations to the bedrock, where it is found in California, Russia, Australia, and elsewhere in placers with gold. Zircon has not as yet been found in place in California, but is abundant in beautiful but small crystals in the alluvial sands. In cleaning up hydraulic mines it might be collected by the ton if it had any value, but zirconia is not much used in the arts. The sands and final concentrations from the hydraulic mines are very interesting, consisting as they do of gold, platinum, quartz, barite, magnetite, cinnabar, as well as zircons, and sometimes diamonds. Zircon sands are more abundant in some localities than in others; (4578), Spring Valley hydraulic mine, Cherokee, Butte County; (4892), hydraulic mines, Irish Hill, three miles north of Ione, and Arroyo Seco, Amador County, in shallow placers. It is also found in sands, Eagle Gulch and Rock Island Hill, Plumas County (Edman); in splendid crystals at Picayune Flat, Fresno County, and in the sands of the Navarro River, Anderson Valley, Mendocino County.

ABBREVIATIONS.

Aaron—Charles H. Aaron, a California metallurgist and author.

Blake—Professor W. P. Blake, author of a catalogue of California minerals, March, 1866.

B. B.—Before the blowpipe (in the blowpipe flame).

Bx.—Borax, used as a flux.

C. C.—Cubic centimeters, a French measure of capacity.

Ch.—Charcoal.

Dana—J. D. Dana, author of "A System of Mineralogy."

Edman—J. A. Edman, a California mineralogist, of Meadow Valley, Plumas County.

H.—Hardness.

O. F.—Oxidizing, or outer blowpipe flame.

R. F.—Reducing, or inner blowpipe flame.

Soda—Carbonate of soda, used as a flux.

Sp. Gr.—Specific Gravity.

Trask—Reports of Dr. J. B. Trask, first State Geologist.

Numbers in parentheses refer to Museum Catalogue.

ERRATA.

The following are some of the most important errors occurring in this volume, as far as noted. A number of minor typographical mistakes will be apparent to the reader:

Page 67, for "Agalmamolite," read Agalmatolite.
Page 67, tenth line from bottom of page, for "Calaveras," read Nevada.
Page 68, twenty-fourth line, for "Tschennigite," read Tchermignite.
Page 82, top line, after "Borax Lake," read Lake County, California.
Page 123, seventeenth line from top of page, for "which will be found," read will be found.
Page 135, for "one 'poud' equals thirty-six pounds or nearly," read one "pond" equals nearly thirty-six pounds, or 526.64 ounces Troy.
Page 145, fourth line from top of page, for "So far as the making," etc., read So far as making the very finest grades of pottery is concerned.
Page 149, for "E. T. Stein," read E. T. Steen.
Page 150, fourth line from top of page, for "shistose," read schistose.
Page 150, eleventh line from top of page, for "melanconite," read melaconite.
Page 152, for "Mess Copper," read Moss Copper.
Page 156, twenty-fifth line from top of page, for "intended to use sulphur," read intended to use sulphuric acid.
Page 156, thirty-first line, same error.
Page 158, second line from top of page, for "this mineral sulphate," read this mineral is sulphate.
Page 180, twenty-first line from top of page, for "Buryla," read Baryta.
Page 186, fifth line from bottom of page, for "experiment," read experience.
Page 231, seventeenth line from top of page, for "H 67," read H 6–7.
Page 276, ninth line from top of page, for "demorphous," read dimorphous.
Page 278, twenty-third line from top of page, for "Hamadau," read Hamadan.
Page 283, thirteenth line from top of page, for "sound pump," read sand pump.
Page 285, fifth line from top of page, for "in wide grate bars," read on wide grate bars.
Page 297, fifteenth line from top of page, for "Santa Meta," read Santa Rita.
Page 300, fifteenth line from top of page, for "mixed with sand; several grades," read mixed with sand several grades;
Page 305, thirteenth line from bottom of page, for "water where standing," read water there standing.
Page 317, twenty-seventh line from top of page, for "Stromeyite," read Stromeyrite.
Page 317, twenty-eighth line from top of page, for "contain," read contains.
Page 319, twenty-third line from top of page, for "manganese and iron," read manganese or iron.
Page 330, eleventh line from bottom of page, for "leavs," read leaves.
Page 354, top line, for "chryotile," read chrysotile.
Page 355, fourth line from bottom of page, for "which readily dissolve in excess," read the precipitate readily dissolves in excess.
Page 356, twenty-fourth line from bottom of page, for "metallic," read malleable.
Page 365, eighteenth line from bottom of page, for "sulphates," read sulphate.
Page 373, fifth line from top of page, for "nitrio," read nitro.
Page 381, thirteenth line from top of page, for "a large area, in bodies of mineral," read a large area; bodies of mineral, etc.

INDEX.

FIRST BIENNIAL REPORT

OF THE

BUREAU OF LABOR STATISTICS

OF

CALIFORNIA,

FOR THE YEARS 1883-4.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1884.

TABLE OF CONTENTS.

ERRATA.

Page 131, twelfth line from top, for "answers," read "answerers."

Page 169, Japanese in California, for "86," read "186."

Page 189, line 21, in "$91,675,024,800," leave out first "9"; line twenty-two in blank, read "49 years."

Page 232, in table for 1883, for "8," read "7."

Page 233, in first table for 1883, for "8," read "7"; in second and third tables, for "2,220,-000," read "2,220,000,000."

Office of State Bureau of Labor Statistics,
San Francisco, September 30, 1884.

To his Excellency George Stoneman, *Governor of California:*

Sir: In accordance with the law passed by the Legislature, approved March 3, 1883, I have the honor to submit to the twenty-sixth session of the Legislature, through you, the first biennial report of the Bureau of Labor Statistics.

Very respectfully,

JOHN S. ENOS, Commissioner.

CHAPTER I.

THE SCOPE AND AIM OF THE BUREAU.

The Legislature of California, at its session in 1883, animated by the progressive ideas which seem to be the birthright of the people of the Pacific Coast, enacted a law establishing a Bureau of Labor Statistics. The Governor approved the Act on March 3, 1883; and soon after, having appointed the Commissioner, the bureau was established in the City of San Francisco, which, being the industrial and commercial center, presents the field wherein the greater portion of the labor of this bureau has to be conducted. The Bureau of Labor Statistics was established at a time when enterprising capital was reaching out for and encouraging industrial development. The State just then had emerged from a period of commercial depression, and new avenues of investment and development of resources were then being eagerly sought and discussed. That was, indeed, the leading characteristic of commercial and industrial life at that time, as it is to-day, though in a greater degree.

Could the motives of the honorable Senators and Assemblymen who voted to establish this bureau be inquired into, it would, no doubt, be found that they obeyed but the general impulse and desire in casting their votes to put the prosperity of this State upon the firmest basis, by advancing its industrial interests. Therefore this bureau, if established for any purpose, was established for a practical one; and to carry out that purpose necessarily involved an enormous amount of labor, indefatigable industry, and not a small amount of practical knowledge. It is the more to be regretted that the Legislature, in its wisdom, saw fit to make the appropriation at my disposal entirely too small to accomplish that which should be accomplished in order to make this bureau what it should be. However, I am aware that Bureaus of Labor Statistics are still looked upon as in the experimental stage, although they are not so in reality. For, wherever established, they have rendered invaluable service, in furnishing data and information, without which the Legislature and the public at large could never have arrived at a just estimate of our industrial condition. Those who have watched their operations are, therefore, no longer doubtful concerning their usefulness. They admit their necessity, and marvel that so valuable adjuncts to the body politic should not have been established long ago.

To Massachusetts belongs the honor of having established the first Bureau of Statistics of Labor. This was in the year 1869. Pennsylvania followed, in the year 1872. Ohio next established a bureau, in 1877; and New Jersey, in 1878. Then their usefulness was recognized; and in 1879, Missouri, Illinois, and Indiana followed the example. Again, in 1883, New York, Michigan, Wisconsin, and our own State of California fell into line; and, in 1884, Iowa, Maryland, and the National Bureau were established. I append herewith a table showing the appellation of these bureaus, their location, the chief officers, and the year of their establishment, for easy reference:

BUREAUS OF STATISTICS OF LABOR IN THE UNITED STATES.

States.	Name of Office.	Year established in	Presiding Officer.		Post Office Address.
			Title.	Name.	
Massachusetts	Bureau of Statistics of Labor	1869	Chief	Carroll D. Wright	Boston
Pennsylvania	Bureau of Industrial Statistics	1872	Chief	Joel B. McCamant	Harrisburg
Ohio	Bureau of Labor Statistics	1877	Commis'r	Henry Luskey	Columbus
New Jersey	Bureau of Statistics of Labor and Industries	1878	Chief	James Bishop	Trenton
Missouri	Bureau of Labor Statistics and Inspection	1879	Commis'r	H. A. Newman	Jefferson City
Illinois	Bureau of Labor Statistics	1879	Secretary	John S. Lord	Springfield
Indiana	Bureau of Statistics and Geology	1879	Chief	Wm. A. Peelle, Jr.	Indianapolis
New York	Bureau of Labor Statistics	1883	Commis'r	Chas. F. Peck	Albany
California	Bureau of Labor Statistics	1883	Commis'r	John S. Enos	San Francisco
Michigan	Bureau of Labor and Industrial Statistics	1883	Commis'r	John W. McGrath	Lansing
Wisconsin	Bureau of Labor Statistics	1883	Commis'r	Frank A. Flower	Madison
Iowa	Bureau of Labor Statistics	1884	Commis'r	E. R. Hutchins	Des Moines
Maryland	Bureau of Statistics of Labor	1884	Chief	Thos. C. Weeks	Baltimore
Washington	National Bureau of Labor Statistics	1884	Chief	Thos. Connery	Washington

The Act under which this bureau is now exercising its functions is as follows:

CHAPTER XXI.

An Act to establish and support a Bureau of Labor Statistics.

[Approved March 3, 1883.]

The People of the State of California, represented in Senate and Assembly, do enact as follows:

Section 1. As soon as possible after the passage of this Act, and every four years thereafter, the Governor of the State shall appoint a suitable person to act as Commissioner of a Bureau of Labor Statistics. The headquarters of said bureau shall be located in the City and County of San Francisco; said Commissioner to serve for four (4) years, and until his successor is appointed and qualified.

Sec. 2. The Commissioner of the bureau, before entering upon the duties of his office, must execute an official bond in the sum of five thousand (5,000) dollars, and take the oath of office, all as prescribed by the Political Code for State officers in general.

Sec. 3. The duties of the Commissioner shall be to collect, assort, systematize, and present, in biennial reports to the Legislature, statistical details, relating to all departments of labor in the State, such as the hours and wages of labor, cost of living, amount of labor required, estimated number of persons depending on daily labor for their support, the probable chances of all being employed, the operation of labor saving machinery in its relation to hand labor, etc. Said statistics may be classified as follows:

First—In agriculture.
Second—In mechanical and manufacturing industries.
Third—In mining.
Fourth—In transportation on land and water.
Fifth—In clerical and all other skilled and unskilled labor not above enumerated.
Sixth—The amount of cash capital invested in lands, buildings, machinery, material, and means of production and distribution generally.
Seventh—The number, age, sex, and condition of persons employed; the nature of their employment; the extent to which the apprenticeship system prevails in the various skilled industries; the number of hours of labor per day; the average length of time employed per annum, and the net wages received in each of the industries and employments enumerated.
Eighth—The number and condition of the unemployed, their age, sex, and nationality, together with the causes of their idleness.
Ninth—The sanitary condition of lands, workshops, dwellings, the number and size of rooms occupied by the poor, etc.; the cost of rent, fuel, food, clothing, and water in each locality of the State; also the extent to which labor saving processes are employed to the displacement of hand labor.
Tenth—The number and condition of the Chinese in the State; the social and sanitary habits; number of married, and of single; the number employed, and the nature of their employment; the average wages per day at each employment, and the gross amount yearly; the amounts expended by them in rent, food, and clothing, and in what proportion such amounts are expended for foreign and home productions, respectively; to what extent their employment comes in competition with the white industrial classes of the State.
Eleventh—The number, condition, and nature of the employment of the inmates of the State Prison, county jails, and reformatory institutions, and to what extent their employment comes in competition with the labor of mechanics, artisans, and laborers outside of these institutions.
Twelfth—All such other information in relation to labor as the Commissioner may deem essential to further the object sought to be obtained by this statute, together with such strictures on the condition of labor and the probable future of the same as he may deem good and salutary to insert in his biennial reports.

Sec. 4. It shall be the duty of all officers of State departments, and the assessors of the various counties of the State, to furnish, upon the written request of the Commissioner, all the information in their power necessary to assist in carrying out the objects of this Act; and all printing required by the bureau in the discharge of its duty shall be performed by the State Printing Department, and at least three thousand (3,000) copies of the printed report shall be furnished the Commissioner for free distribution to the public.

Sec. 5. Any person who willfully impedes or prevents the Commissioner or his deputy in the full and free performance of his or their duty, shall be guilty of a misdemeanor, and upon conviction of the same shall be fined not less than ten (10) nor more than fifty (50) dollars, or imprisoned not less than seven (7) nor more than thirty (30) days in the county jail, or both.

Sec. 6. The office of the bureau shall be open for business from nine (9) o'clock A. M., until five (5) o'clock P. M. every day except non-judicial days, and the officers thereof shall give to all persons requesting it all needed information which they may possess.

Sec. 7. The Commissioner shall have power to send for persons and papers, whenever in his opinion it is necessary, and he may examine witnesses under oath, being hereby qualified to administer the same in the performance of his duty, and the testimony so taken must be filed and preserved in the office of said Commissioner; he shall have free access to all places and works of labor.

Sec. 8. The Commissioner shall appoint a deputy, who shall serve the same time and have the same powers as the said Commissioner, as set forth in the preceding sections; he shall procure rooms necessary for offices at a rent not to exceed fifty (50) dollars per month, and may provide the necessary furniture at an expense not to exceed five hundred (500) dollars.

Sec. 9. The salary of the Commissioner shall be twenty-four hundred (2,400) dollars per annum, and the salary of the Deputy Commissioner shall be fifteen hundred (1,500) dollars per annum, to be audited by the Controller and paid by the State Treasurer in the same manner as other State officers are paid; there shall also be allowed a sum not exceeding five hundred (500) dollars per annum for stationery and other contingent expenses of the bureau.

Sec. 10. The sum of ten thousand five hundred (10,500) dollars is hereby appropriated, out of any money in the State Treasury not otherwise appropriated, for the expenses of the bureau for the first two years after its organization.

Sec. 11. This Act shall take effect and be in force from and after its passage.

It will be seen that the bureau is intended to cover an enormous field of action. To cover it is doubly difficult on account of the reluctance which is found throughout society to give information concerning matters which in a certain sense are private, and have certainly always been considered so. The officers of the bureau, accordingly, have often met with difficulty necessitating argument in order to obtain desired information. It is pleasant to state, however, that in no case has it been necessary to resort to extreme measures to acquire the desired end. Generally a very little reflection has convinced all that the officers are working for the general good and for no other purpose. Still, the bureau has been hampered to a certain extent by this sometimes annoying addition to its already formidable list of labors. But it is also just to say, that the greater amount of information acquired was given voluntarily by those who take an interest in the advancement of our labor and industrial interests, and who are anxious that the Legislature should be furnished with full and correct information upon all subjects liable to assist the members in arriving at just conclusions and estimates relative to the necessity of all measures concerning the condition and welfare of the laboring classes. Statistical facts only will enable a Legislature to proceed intelligently on questions of industrial and labor legislation. In this report, therefore, it has been my constant aim to present facts and not theory. No subject has been more generally philosophized upon than that of labor, and for that very reason I have abstained from indulging in speculations upon so ramified a subject.

CHAPTER II.

THE LABOR QUESTION.

In considering the condition of labor in this State it should at no time be overlooked that California, up to a few years ago, was never thought of as a manufacturing State. We commenced with mining, continued with agriculture, and now suddenly see displayed before us the grandest possibilities are following the arts and manufactures. Consequently, while factories are springing up on all sides, we have no manufacturing population. Five years ago the question was: "What shall we do with our girls and boys?" To-day there are not enough of them at certain seasons of the year to supply the market. A truce has been struck between capital and labor, as there always will be when there is work for all and wages sufficient for the workman to maintain and rear families. California to-day has no pauper population, except that which has become voluntarily so, and which therefore is classed much more properly among the vicious and criminal classes. Scarcity of labor and help always acts as a deterrent to struggling industries and retards incipient enterprises. Capital, therefore, is anxious to encourage immigration, while labor is rather inclined to discourage it. You will find in this condition of things the explanation of the apparent contradiction as to the condition of trade from the standpoint of the employer and employé.

Take, for instance, the foundry business. The employers will uniformly tell you that business is excellent and that skilled mechanics are wanted, while the workmen insist that business is bad, that there is an abundance of help, and that a decrease in the wages of labor is imminent. It is the old story of the struggle between capital and labor over the control of the market. However, a careful investigation has convinced me that an increase of the laboring population (in which term I include skilled artisans and mechanics) is not at present desirable and that it will not inure to the mutual advantage of employer and employé. Certain industries are oversupplied with help and unless there is an extension of trade there is danger of crowding the labor market. But it is also true that capital stands ready to invest in most any enterprise upon the slightest encouragement, and that no better encouragement can be offered than the assurance that there is a sufficient supply of help. Here, as in all things, it is to the advantage of both sides to mutually yield something.

In other branches of enterprise there is a positive scarcity of labor all the year round, a fact which is supposed to keep wages high and which is consequently a benefit to those who are engaged in it. Nothing, however, could be a greater mistake. It simply opens the market for eastern competitors, sends money out of the State which should remain here, and in the end cuts down the profits of employer and employed to the basis of cheap Eastern labor. These remarks apply not only to the mechanical trades, but to agriculture and horticulture as well. In this class of industry, of course, the idea of Eastern competition and its evils is excluded, but in its stead we have the arrested development of the resources of the State, which means not so much that millions of acres of land will continue to be uncultivated, but that those who have undertaken to turn the sod and make it bring forth will have no markets for their products. It is the disposal and not the creation of products which brings wealth and prosperity. It is a deplorable fact that during the past years both these factors have suffered severely from the want of help. We have heard and have indeed known of fruit remaining unpicked on the trees and grapes remaining ungathered in the vineyard. Grain has remained in the fields exposed to the rain because men could not be secured to thrash it, and hay has rotted in the stacks because there were no farm hands to handle it. Farmers have been compelled to take what help they could get, whether they were white or Chinamen, nor has it been a strange sight to see in California women and children labor in the fields. Boys and girls, in fact, have been in great demand in the vineyards, on the hop farms, and in the berry gardens. Here the work was light, agreeable, and remunerative—three qualifications which deprive it of every objectionable character.

Hitherto the one great objection to an increase of the unskilled white labor population in California has been, that necessary as it was to have more help during Summer and harvest, the manner of husbandry in this State was such as to assure those who labor for others, work only for three, or at the highest, five or six months during the year. It was admitted to be an unnatural condition of affairs, and one which should be remedied, but which, under prevailing circumstances, could not be changed, especially as long as Chinamen in sufficient numbers could be hired during the busiest seasons of the year. But now Chinamen can no longer be hired at will, for they are as scarce as white laborers and demand fully as much pay. What is to be the result? Here, in my estimation, is the greatest and most important problem which the people of California will have to solve. The coming of Chinamen was tolerated and encouraged for many years. As a natural consequence they made for themselves a place in the industrial economy of the State, preventing thereby the natural increase and provision for a white laboring population. Employers could not expect white laborers to spring out of the ground, when the Chinese influx ceased; nor can they now expect to remedy the evil, which a short-sighted policy, preferring a homeless wandering heathen to a settled American with a family, brought upon them, without suffering the consequences. But the great danger is that they are unwilling to suffer these consequences, and that rather than undergo the annoyances of a settlement which would, once for all, put the question of labor upon a right basis, they will look only to the immediate future and continue to encourage or begin again to encourage Chinese immigration. I take pleasure in stating, that on account of the strong anti-Chinese feeling pervading all classes, the danger is remote. But reason is apt to stop at the purse and the fuller the purse the less apt is reason to overcome the obstacle.

We must expect and may look for a pro-Chinese agitation from certain classes, which will urge as its one great excuse the scarcity of labor and the impossibility of making white people take the place of Chinese. They will not work "for Chinese pay and Chinese treatment," but that will, no doubt, be the second great cause of their philo-coolie proclivity. Still, the fact remains that white laborers are urgently required to take the place of the absent coolie, and that employers, if they want to secure their laborers, must offer them such inducements as Caucasians may expect.

If the size of their landed estates and the mode of cultivating them preclude the employment of civilized labor under civilized conditions, it is better that such estates lay waste, than that they be made the means of perpetuating the coolie system. It is now for the people of California to choose whether they will take advantage of such benefits as the "Restriction Act" confers, or whether they will wink at the violation of its provisions to obtain a renewed supply of the "Heathen Chinee."

Such being the condition of the labor market it follows that the condition of the laborer corresponds with it.

In the first place, as has been stated already, labor finds employment without much difficulty, although the opinion prevails with certain classes that the supply is quite equal to the demand. In the second place, the industrial development being recent, certain practices, which prevail in the East, such as the system of paying wages in orders on stores, and other abominations, have not yet, and it is to be hoped never will, find a foothold in this State. Again, our laws are liberal and seem to recognize the scriptural admonition, that the laborer is worthy of his hire, and the result is that the man who works generally receives his pay in hard cash, and is left to spend it as he sees fit.

It may be said here at once, that also in the amount of pay received, even taking into consideration the slightly higher cost of living, California wage-earners have decidedly the advantage of their eastern brethren. Of course it is not desired to convey the idea that labor in this State is always well paid, or that the pay is in every case enough. The statement is wholly a comparative one. It is a sentiment implanted in the human breast that every man should value his work highly, and it is an incentive to progress and an inducement to reward exertions that every man hopes to be able to increase his earnings, and for these reasons alone it would be unfair to assume that laborers and mechanics in this State are always paid well enough. On the contrary, in some branches of the industries, the wages, though high apparently, will be found to yield but a small annual income. It would lead too far from the purpose of this portion of my report to inquire into the rates of wages and make comparisons at this place, the intent here being to show the natural condition of the wage-worker in general terms. Nothing is more interesting and more important than to learn how he lives.

Here again it can be truly said that in this State the mechanic or laborer lives far better than his eastern colleague.

Look at the one item of house-rent. Even in the City of San Francisco there are no tenements, or anything approaching to them. Nearly every family can afford to live in a house by itself, or have at least a flat, with abundance of air and light. Few families are found, even when they consist of but two persons, who occupy less than three rooms. Rent is relatively lower than any other necessary of life, landlords being now well satisfied to receive six per cent net upon their investments.

Again, there is an abundance of houses to select from in nearly all parts of the city, so that the employed are seldom compelled to spend long hours, which should be devoted to rest and recreation, in going to and coming from their shops and factories. As a rule, the houses of all classes will be found to be clean, light, and airy. There is little squalor and filth to be found in any part of San Francisco, and even "Tar Flat" and the "Barbary Coast" have nothing to show that will approach the wretchedness known to exist in other cities. Of course no reference is here made to the condition of Chinatown. The well-housed condition of the laboring classes has great influence upon their sanitary condition. The vital statistics of the Board of Health are more eloquent upon this subject than I ever can be, and to them I would refer the inquirer.

But there is another subject intimately connected with this question, that of our mild climate, which enables people to enjoy outdoor life all the year round, and which makes stoves, except for cooking, unnecessary even in midwinter. The saving in the matter of fuel is not the only advantage in this connection. There is a much greater and more important one. It is that the cost of building houses is much smaller than in countries where the cold of Winters has to be guarded against. A temperate industrious man finds here less difficulty than anywhere else in becoming the owner of the house he lives in.

Next, as to the matter of food, there are some of the necessaries of life which can be had very cheap, while there are others which sell so high as to put them almost out of the reach of people of limited means. To the former class belong flour, potatoes, fruits, tea and coffee, rice, beans, fish; and to the latter, meat, many kinds of groceries, and, strange to say, vegetables, which should be cheap and abundant above everything else. Fowl and game are also high-priced articles.

In the matter of clothing, also, the California consumer is at a disadvantage. Although many million pounds of wool are raised in this State it is but little manufactured into clothing here. We prefer to ship the wool East and bring back ready-made clothes, containing more shoddy, jute, and cotton than wool, and to add to its cost that of double transportation.

Finally, in the matter of amusements it may be safely said that the California workman and mechanic knows how to extract more pleasure and enjoyment out of life than the people of any other country, paying therefor, however, a disproportionately larger sum. One cause of this happy condition of things is that Sunday with us is not only a day of rest, but also of recreation. It would indeed be wrong to say that the people are not religious, for they are; but they are certainly averse to burying themselves in their houses on Sundays in accordance with the narrow-minded teachings bequeathed to the world by the Puritans.

There is still another feature which is calculated to make the lot of the wage-worker more pleasant, and that is the spreading tendency to shorten hours of labor. It is now recognized that the laborer requires not only time to rest, but also time to devote to his family and to improve his mind, and there is a growing disposition to curtail the hours of labor accordingly. Again, it will be found that the citizens of California value life and its cares more easily than those of the East. There is less intensity in the pursuit of gain, if the love of money is as strong; and this disposition to take life more coolly makes itself felt in every branch of industry, and particularly in those which have been longest established, as strangely enough those who have been longest in the country are also most disposed to yield to the inclination to save their nervous powers.

Still another subject which is intimately connected with the material condition of the laboring classes is the employment of children in factories, mills, and other industrial establishments. It being against nature that little children should work, it is always found that the average parent is unwilling that his child should labor when he is able to win bread enough for the whole family. Accordingly, in those places where young children do work, they work out of necessity and because their wages are needed for the support of the family. As a rule, the California mechanic and laborer is too well conditioned not to be able to allow his child to enjoy the benefits of a public school education, and for this reason few children under fourteen years of age are found in the shops and factories, despite the fact that there is a great and growing demand for the youths of both sexes in numerous avenues of the industries. It is seldom that a child's earnings are required to help support a family; and when they are, it will generally be found that sickness or some other calamity is the cause. It furnishes additional proof that the condition of the wage-earning class is good and prosperous.

Lying peculiarly within the sphere of government control is the apprentice question. It is a subject fraught with importance to both capital and labor, and the importance of which promises to increase as the necessity for training skilled labor becomes more and more essential to the progress of industrial arts. The law and system of apprenticeship, as they exist at present, are a remnant of the middle ages, when admittance to all trades was wholly in the control of guilds.

We have in our times trades assemblies and unions, the members of which are striving to obtain control over the number of apprentices to be admitted to learn the trades in the various workshops. This has been, and will continue to be, a fruitful source of difference between employers and employés, and has led to strikes more than once. For instance, the iron molders have a rule that there shall be admitted but one apprentice to eight journeymen molders in any foundry. It is but natural that the employers should attempt to break down this rule, for they are directly concerned in creating a full supply of skilled labor, and it is just as natural that the trades union men should be fully as anxious to maintain the rule, for it is to their interest to have the supply of skilled hands short, that wages may continue high. It is self-protection on both sides, but it does not protect the youth anxious to learn a trade, and that is where it works wrong. The matter of supply and demand may always be left to regulate itself, but the young man desirous of learning a trade should receive encouragement instead of discouragement. Besides, this curtailment of the number of learners is rapidly reducing the condition of American apprentices to the European standard. Formerly, every man or boy in this country who worked, whether he was learning or not, received pay. At present, it is not at all unusual for a boy to pay a bonus for the privilege of learning a trade. Much, of course, is to be said on behalf of the journeymen, who object to the indiscriminate increase of the apprentice force in the shops, and altogether the question is one which requires careful study and elucidation before a solution should be attempted.

Closely connected with the subject of apprentices is another, and one which is now attracting much attention. It is that of industrial education and technical schools. No part of the public funds in this State is now appropriated for such purposes, the acquisition of industrial education being left to individual effort. Yet to an unbiased observer it appears rather strange that in an age when the exact sciences are cultivated to the highest degree, a State which makes some pretension to being or becoming a manufacturing commonwealth, the cause of technical education receives no State aid. It is one of the idiosyncracies which we have inherited from the old world, that the boy who desires to learn the dead languages should be enabled to do so at the expense of the State, while he who endeavors to acquire a knowledge of practical things which tend directly to make the country powerful and rich must depend upon his own means and exertions. The youths of California are more than eager to embrace every opportunity to acquire technical knowledge, as is shown by the crowded attendance at the solitary class in one of the San Francisco night schools where technical draughting is taught. A foundry firm, which undertakes to give its apprentices not only practical but also theoretical instruction, has a similar experience. Here the applications by young men to be admitted to apprenticeship are always far more numerous than are the openings, and among them are not only those of the sons of poor men, artisans, and mechanics, but of the sons of some of the richest and most influential of our citizens. These apprentices do not come to learn a trade simply, they come to learn the whole business from the bottom up. Yet even here the journeymen's rule restrains the admissions, although it is admitted that these apprentices will never contribute to crowd the labor market; on the contrary they will increase the demand for skilled labor. This particular establishment has already trained up a large number of young men, practically and theoretically, and among them there are many who have at once jumped to the head of their profession. They are in great demand in various parts of the coast, Mexico, the Hawaiian Islands, China, Japan, and even Africa. Wherever an industrial concern needs a skilled foreman, or engine-builder, or foundryman, these young men are sent. They have the reputation of being well trained, and their work sustains their reputation. The result is that the trade of the establishments, which are under the management of San Francisco trained boys, is directed to this city. Hundreds of orders for pumps, engines, boilers, and other machinery have been secured just in this manner.

San Francisco is recognized as the proper source from which to draw supplies of that kind. It is folly to maintain that the whole State has not been benefited in this manner. No stronger, or a more convincing plea, in behalf of industrial education, can be adduced, in my humble opinion. Of course, the trade unions claim that the limitation of the number of apprentices is a measure of self-protection, and in some cases of self-preservation. It is the old feud between capital and labor, only in a different form. It is certain that the trades unions must look out for themselves and their interests, for even the best intentioned employer cannot maintain a high rate of wages in the face of a glutted labor market, of which his competitors in trade are taking advantage. But, is not the limitation of apprentices a two-sided arrangement, and a sword that cuts both ways? Is it not a direct inducement to manufacturers to encourage the immigration and importation of eastern skilled labor, while it keeps the boys of our own people away from honest work, making hoodlums and worse out of them? Are not our reformatory institutions filled with young men who never learned a trade, but who, if they had, might to-day lead honest lives?

There is still another matter closely identified with California labor matters, and that is the extension of the manufacture of home products. Ours is a producing State, preëminently so, and it is plainly to our advantage to prepare the things we produce for the consumer as much as we can. Yet the fact is, that not only do we make use of but a small percentage of our resources, but, further, that the greater portion of our products pass into the world's market in their raw state. In every direction inquiries as to the cause of this state of affairs are answered by the statement that the supply and cost of labor is such as not to allow the conversion of these products into manufactured goods. Now, it is undoubtedly a fact that in many cases the cost of labor is so high in this State as to preclude the idea of ever successfully establishing certain industries in this State, unless labor saving machinery should make it possible. This is the case where our labor would come in competition with European pauper or Chinese coolie labor, as in sericulture. The establishment of these industries at such a price, instead of being a benefit, would be a calamity. But there are many other branches which are neglected from the lack of skilled labor only.

Capitalists are much averse (not to paying high wages, for that is a matter that does not affect them at all as long as they can compete with other sources of supplies), but to embark upon enterprises which they may have to abandon on account of the uncertainty of the supply of labor. It is true that unusual encouragement has been given to home industries during the past three years. Our people seem to have realized that prosperity comes not only from producing, but also from making use of the products of the soil. They have discovered that we buy abroad many things that we can produce ourselves, and they are making a brave attempt at doing so. I take little hesitation in saying that this expansion of the home industries has contributed more to the prosperity of our State during these years, than has the abundant rainfall, upon which alone hung formerly our hopes and fears of bountiful harvests and active trading. It is a movement that is deserving of all the encouragement that can be given it from any side. The possibilities of California's industrial future are great indeed. They are so great that the highest estimate can hardly be too high, and it is now that we are laying the foundation to her future greatness.

CHAPTER III.

INDUSTRIAL DEVELOPMENT.

The difficulty which this bureau meets with in reviewing the condition of the various industries for the first time, consists in the fact that hitherto no settled attempt has ever been made by any person or body in this State to acquire any information or to gather statistics concerning them. So little attention has been given to the development of our industries that many have sprung into being and prosperity without ever becoming known, and to this very day our people buy as eastern and foreign goods those that are manufactured right in their own midst. Again, the limited means at the disposal of the bureau have forbidden as extensive researches as might be wished, and many sources of knowledge which might have been availed of have necessarily been closed against me. It should be further understood that the scope, purpose, and necessity for a Bureau of Labor Statistics is yet but little understood, and that much information that should have come to us quite readily, has been kept from us, consequently the reports are not as particular in their statements of facts as they might be. However, as will be seen, much has been accomplished.

IRON AND STEEL.

The iron industry is one of the most promising in this State, and one which has made considerable progress during late years. The efforts to work native iron ore have been more than successful, and to the list of the products of our State has certainly been added that of iron. In the heart of the mountains, where in 1849 the hardy miner looked for gold, there is now heard the roar of the blast furnace, and the sides of the hills yield the baser but more useful metal. The production is as yet restricted, for, like all infant enterprises, it has had its backsets. But enough has been done to show that iron mining can be made to pay, and that the quality of California pig-iron entitles it to the first place when that particular matter comes into question. So far, the owners of the works have been able to successfully compete with the importers of foreign iron. It must be remembered, however, that the output has been too small to constitute a large factor in the market, and it remains for the future to demonstrate what shape matters will take when the yield shall have become large enough to affect the import trade. The success of the works at Clipper Gap has led others to imitate their example. Valuable deposits of iron ore have been discovered in various parts of the State, and the owners of several of these are now preparing to work them. Great things are expected from these enterprises, and it is to be hoped that these not unreasonable expectations may be duly fulfilled. The iron industry has made good progress also in other branches. Some years ago when mining operations became less active, the foundries and shops which found the mines their best customers, were quite seriously affected by the loss which a cessation of that class of work entailed upon them. It was then thought that there was not enough work of other descriptions to keep all the establishments busy, and it was freely predicted that a good many of the machine works would soon be idle. These anticipations of disaster have happily proved false. It is true there was a depression for a time, but instead of resulting in permanent loss, it ended in advantage. The question having resolved itself into a struggle for existence, the foundrymen and machine-builders bravely met the issue. They soon found that other classes of work paid as well, and they soon found enough of that to keep them all busy. In the end, not a single shop was compelled to close up, and to-day the smoke of innumerable chimneys gives evidence of the prosperity of this branch of industry, which is now established on a firm basis, for it is now supplying the wants, not of a single class, but of a growing and prospering industrial community. The industry has branched out considerably, especially in the last two years. Our local manufacturers are enterprising and quick to take advantage and make use of new inventions. The discovery of new processes of making steel has been promptly followed by the erection of new works. One of them has been successfully in operation in Oakland for some time past, and finds that it is on paying ground, and that none of the suppositious causes of the foretold failure have so far made themselves felt. These works are run in connection with the Clipper Gap iron mine, converting its product into malleable iron and steel. Another work has been temporarily established at Melrose, also in Alameda County. Here, too, a new process of making steel has been tested, and with so much success that the promoters of the enterprise are now looking for a site on which to locate permanently. The third establishment of this kind is now in course of construction at Benicia, the citizens of that town having offered the inventor and others interested in his patent process of converting iron into steel, handsome inducements to locate in that town. It is yet too early to speak of the success of that enterprise, for its forges have hardly yet been lit. In addition to these, the Union Iron Works, in connection with their extensive new establishment at the Potrero, in the City of San Francisco, will erect and operate steel works which are to be second to none in the State. Then there are the Rolling Mills people, also located at the Potrero, who have just erected an addition to their works, which is to be specially devoted to the manufacture of steel. Next, a large iron works is being erected at Los Angeles, if, indeed, that establishment is not already in full operation when this report leaves the printer's hands. Finally, and fully as important as the preceding, a number of capitalists have become interested in the iron deposit found in the vicinity of Colton, and have begun the erection of furnaces for the purpose of working them. It is reported that this company will manufacture, as well as produce. The older iron working establishments, the foundries, machine shops, boiler shops, especially those of San Francisco, have also gradually extended their capacity. But it should be borne in mind, with regard to these, that they have just passed through a transition period, for, as in former years, their work was principally for the mines, now it is for the commercial, agricultural, and industrial interests. If some of them have not made as much progress as others, it is simply because the latter more quickly saw the signs of changing times, and seized the iron while it was only beginning to get hot.

Brief as this review of the iron industry is, it would still be incomplete if mention was omitted of the period of depression which prevailed in the Spring of the year 1883, and which deterred many from progressing with the enterprises then about to be put into execution. The Winter of 1883 was an unfavorable one to the iron industry of the whole United States, and particularly in the Eastern States, where there was a general shutting down of mills and furnaces. Over-production was the cause, and, as is always the case, an over stock led to lower prices. There was no over-production on the Pacific Coast, but the eastern reduction of prices was soon felt here, and all establishments which were competing with eastern goods were compelled to make similar concessions. This competition finally became so great as to make local manufacture unprofitable, and in the end quite a large number of hands had to be discharged from various establishments. Matters in the East began to mend again in the Summer of 1884, and since that time our local manufacturers, also, have been slowly regaining ground.

In this place may also be properly considered the nail and tack-making industries. Both have but lately been introduced in this State, and both have so far met with the most gratifying success. Indeed, the success of the nail factory has surprised even the most sanguine. The factory is a well appointed and large one, and capable of supplying a great portion of the home demand for that useful little article, the nail. However, the new enterprise has also had its trouble, this being nothing less than a strike of the nailmakers. To properly learn to run a nail-making machine is supposed to require years of learning and experience, and the places of these men, therefore, could not be filled satisfactorily by green hands. The cause of the difficulty was a difference between employer and employés about wages, in which a new invention, termed a self-feeder, played an important part. In short, the men demanded a certain remuneration, and the company offered another, and neither being willing to yield, the strike was the result. But it is in evidence that the men did not strike because they thought their pay insufficient, but because they thought they were able to get more, having the company in a corner, so to speak; for the fact is that the pay of some of them, all doing piece-work, averaged from $9 to $18 a day. The formation of a Union of the Amalgamated Ironworkers' Association, with and under the advice of recently arrived nailmakers from the East, is also alleged to have had something to do with the strike. A few weeks of negotiations proving fruitless, the company put on a bold front and set green hands to work. The strikers viewed this move with derision, but the company has steadfastly adhered to its purpose, and for months the mills have been running with the aid of this labor. The green hands have not been a great success, neither have they been a great failure, and the strikers were finally defeated by trained nailmakers brought from the East.

The mills which, when running full, distributed about $15,000 monthly in wages, now put about one half that sum in circulation. The tack factory has had no such difficulty. Here a large number of boys and girls have found steady employment all the year round, and at wages far above those paid by any similar establishment in the East. During the first year of its existence it has disbursed over $100,000 in wages alone.

SERICULTURE.

The subject of silk culture has already received the attention of the Legislature, and it would hardly be the duty of the Bureau of Labor Statistics to report upon the condition and prospects of that industry, if its establishment did not involve a question of labor which will become a very important one. It should be understood, first of all, that if silk culture is not a success, its want of success is due to this very labor question. The chief silk-producing countries are Italy, France, China, and Japan. In those countries labor is cheap, and because it is cheap silk culture is profitable, and, correlatively, it is because the cost of labor is high, silk culture is not successful in the United States, and least of all so in California. There are certain processes in the manufacture of silks which can only be done by hand. Of such is the reeling of the cocoons, the most important as well as the most expensive and laborious of all processes. The cheap labor of the countries named above allows this work to be done at an almost insignificant cost compared to what it would be in the United States; and here is the problem which the advocates of silk culture will have to solve before they can make a financial success of it. Yankee ingenuity so far has vainly been called upon for an invention of a silk-reeling machine. No piece of mechanism has yet been constructed that possesses the same delicacy as the fingers of the human hand in handling the cobwebby fibers of the cocoons.

The popular mind is in the habit of confounding silk manufacture with silk culture. Silk manufacture has been successfully established in the United States and in this State also, but silk culture has not. The former obtains its raw material from abroad, after the reeling process has already been performed. The latter imports only silkworms and produces cocoons which are uselessly stowed away for want of reeling facilities, the first requisite of which is the cheapest of cheap labor. The State of California, in a wise endeavor to encourage the introduction of new industries, has given State aid and recognition to this also. But with all due respect to the Legislature which gave the appropriation, I doubt whether the subject was completely comprehended. It was certainly in the nature of an experiment. But narrowed down, the question becomes simply, whether or not it is desirable, wise, and expedient to attempt to introduce and establish an industry, the success of which depends upon cheap labor of the class employed in Japan, China, Italy, and France. Is it wise that the energies of California should be expended upon such an industry, when a thousand and one better, more promising, and far more surely profitable resources lie still unused and open to enterprising capital? Is it desirable to have a cheap labor population, when there are numerous branches of industries awaiting extension and ready to pay fair wages? In my humble opinion an industry which cannot prosper unless the help which it employs is kept at starvation wages, is a curse and a blight instead of a blessing to any people, and it were better that the site of a mill in which wretched little children and still more wretched grown men and women, earn too little to live decently, were seeded to potatoes than that it should be permitted to spread pauperism, immorality, ignorance, squalor, and want among the population.

The special plea is made in behalf of sericulture that it will give children an opportunity to contribute to the support of the family, and that it will furnish a light and pleasing occupation. But is it not a fact that the industrial situation in California is not to bring occupations to the labor, but to bring labor to occupations. It is the supply of labor which we lack much more than the number of occupations. Again, in the name of common sense, is this country and its population so impoverished, is a man's labor worth so little, that it becomes necessary for children to work? Has California come down to the level of British manufacturing towns, when children have scarcely time to learn their a, b, c, because all their young life is required in helping the parents to earn the daily bread? If child-labor is an evil, then is it not a greater evil to foster an industry which cannot prosper without it? Besides, our vineyards and orchards, and hop gardens, furnish as large a field for work for our little ones as they are well able to cover, and as it is good for them to cover. For the remainder of the year the school house ought to claim them as its own. For these reasons I doubt the expediency of encouraging sericulture until the labor problem connected therewith is first solved, either by the invention of labor-saving machinery or otherwise.

THE BUILDING INDUSTRY.

Among the building trades there has prevailed a most active demand for labor of all kinds, ever since the year 1880, under which state of affairs wages have gone up, while the hours of labor have decreased. Indeed, the demands of contractors and builders were so urgent, especially during the Summer months, that the demands of all mechanics connected with the building industry had to be complied with without opposition. The advance in wages was general, and has been sustained in most cases, although the Winter months with their rains prostrated many building operations. The highest rate of wages paid, and the one at which first-class mechanics were still scarce, was $5 for plasterers, $5 for bricklayers, $2 50 for hod-carriers, $3 50 for carpenters, and $3 50 for painters, with the number of working hours reduced to nine, and in some cases to eight. The building activity was general throughout the entire State, and greater of course in the City of San Francisco. It is by no means an over-estimate to place the sum which has been expended in permanent improvements since 1880, in San Francisco alone, at $15,000,000. It is safe to fix the figure for 1884 at least at $5,000,000, and it was $4,500-000 in 1883. This building movement may justly be considered one of the most substantial signs of prosperity. An analysis shows that the improvements consist largely, very largely, of moderate sized houses, built by the owners of single lots for homesteads, and not by capitalists as investments. There are, of course, also, a large number of the latter, especially where the buildings are divided into so called flats, but the far greater number consists of single houses of convenient size, emphasizing what has been said already, that the industrious, competent wage-earner can, by perseverance and economy, earn enough to purchase and own the house he lives in.

San Francisco, especially, is becoming a city of homes. There is not known here such an institution as Mayday moving. Trucks laden with furniture are quite a rare sight at any time of the year. There is indeed a large floating population living in boarding houses and hotels, but they form but a small part of the whole, and though they formerly impressed upon the whole people a nomadic character, so to speak, which the uninformed still believe to exist; that is a supposition, than which nothing could be more erroneous. A visit to the outskirts of San Francisco will at once dissipate such a notion, for there in little valleys and streets, the existence of which many never dreamed of, will be found thousands of snug little cottages and houses, all holding happy families. Our population has become settled.

OSTRICH FARMING.

The experiment of ostrich farming undertaken in 1883 has been attended with fair success. Twenty-two ostriches were brought from South Africa and placed upon a suitable farm in Los Angeles County. There were eleven hens among the number, of whom six laid three hundred and two eggs, and five not at all. As the first eggs laid by ostriches do not hatch, attempts of having them incubated proved futile, for not one of the birds is over four years of age, although the African farmer from whom they were bought guaranteed them to be eight. Had any number of their eggs hatched out, the farm would have yielded a nice profit to its enterprising owners. As it is, their only return was a quantity of feathers, but few of which are rated as first class. The yield would have been larger if better care had been taken to keep the birds, who are very shy, away from strange sights and noises. These caused them to thrash their wings against the fences, to the total destruction of their valuable plumage. Greater care will be exercised hereafter to protect the birds from intrusion. At least last year's work on the farm was wholly experimental. It was intended to establish the theory that the southern California climate agrees with the ostrich, and that fact has been proved abundantly. The company has invested a capital of $30,000 in the enterprise. The farm contains two hundred acres, one hundred of which are seeded to alfalfa. It is claimed that the farm will support one thousand ostriches, and that it will not take many years before there will be that number on the land. The promoters of the enterprise are very sanguine of success, and are certain that this year's work will be satisfactory to all concerned.

A second farm was established near Mount Fairview, in San Diego County, in the Spring of 1884. It has been stocked with twenty birds, who were prospering at latest accounts.

THE LUMBER INTEREST.

The lumber interests of California are large and valuable. They give employment to many thousand men and bring untold wealth to the State. The necessity of preserving our valuable timber resources has already been recognized by the enactment of a law creating a Forestry Commission, which, no doubt, will report to the Legislature in full.

As falling within the province of the Labor Bureau of Statistics, I merely desire here to point out that the lumber dealers of San Francisco—and they control the market for the whole State—have entered into a contract, with penalties of forfeiture, which if not illegal, ought certainly to be made so, for the purpose of advancing prices and monopolizing the market.

It is, unfortunately, not the province of the State Legislature to interfere in the unlawful spoliation of government lands, which is carried on to a great extent, I am told. But I would, nevertheless, suggest that a full and thorough inquiry be made into the whole subject, for the forests of California are too valuable to be destroyed wantonly and indiscriminately. In addition, I would call the attention of the Legislature to the fact that a number of foreign (English) capitalists have invested heavily in California timber land, and are now reaching out for the control of the lumber business. They have a capital of $10,000,000, and have already managed to secure the mills and lands of five of the largest firms in the business up to the year 1882. Odious as a monopoly is to the American citizen under all circumstances, it becomes doubly so when those who are not citizens aim to establish and maintain one. It should be resisted by all possible means, and it is the duty of the Legislature to see that such gross abuses of our laws, which permit aliens and non-residents to own real estate in the same manner as citizens, do not occur.

That statute was as little designed to furnish speculating aliens with means to establish burdensome monopolies, to the great damage and injury of our own people, as it was intended to be an invitation to British lords and dukes to acquire large landed estates and establish landlordism; and it were better that the common law, which allowed only citizens to become owners of the soil, be reëstablished, than that the present one be made an engine of oppression and wrong by men who are less desirable than the poorest immigrant who comes to this country with the intention of making it his home.

In connection with this subject, it may be mentioned here that there is now being established a large sawmill on Big Farm Island, Alameda County, which is to work on logs to be towed down from the northern coast. It is a new departure in the lumber business.

COTTON GROWING AND MILLS.

Another industry, which it has been thought possible to introduce into this State, is the growing of cotton. That the plant prospers in certain portions of the State, especially in the south, was ascertained long ago, but it was less easy to determine whether it could be cultivated with profit. It was well understood that cheap labor was the great desideratum in this case also, and it was at one time held that the Chinese were the very element required. But a large land owner, who has devoted time and money to experimental cotton growing, soon discovered that the Chinaman would not do in California what the negro did in the South, although in all other respects the attempt was successful. The heavy expense for labor was the cause of the venture being profitless. White labor, under existing conditions, being out of the question, it was determined to try still another experiment—that of importing colored people experienced in cotton planting from the Southern States. Over a hundred of these plantation hands were secured and came to California last Winter, all housed by contract for a certain period, and at a rate of wages much below that current in this State. How this experiment will result remains to be seen. But, if it succeeds, it does so only, because these colored hands, knowing nothing of the rates of wages prevailing in this State, contracted at a lower rate than they will ever again agree to while the local labor condition remains unchanged. Consequently, what now may look like success will not be such, when the experimenter is compelled to rely upon the California labor market, as must eventually be the case. At best, the expediency of bringing cheap labor, and contract labor at that, is very questionable, and ought not to be encouraged.

In the manufacture of cotton goods, an attempt is also to be made. Early in 1883, a company was formed for the purpose of erecting a cotton mill. A convenient site was found in East Oakland, purchased, and the erection of buildings begun. The machinery was ordered in England. The company is reported to have a sufficiency of capital and to be composed of energetic men who may be relied upon to push the enterprise to a successful issue, if the conditions are fairly favorable. The company intends to draw its supply of raw cotton from the south, the Hawaiian Islands, Australia, and other countries, whence it can be brought here at sufficiently low expense to warrant the importation. In this respect, San Francisco is supposed to be situated as favorably, geographically, as any city in the Eastern States. I beg to suggest, however, that unless the advantages are sufficiently great to warrant the payment of better wages than are paid to New England mill operatives, a cotton mill will be a very doubtful blessing for this State.

JUTE AND FLAX WORKS.

The cultivation of jute has been discussed and experimented upon to some extent, with a view of domesticating it. For a number of years past there had been in operation in East Oakland, a jute mill, where the spinning and weaving of burlap was prosecuted with varying success. The raw material was obtained from Calcutta, together with a number of experienced hands from the same place. The scarcity of white labor led to experiments with Chinese labor which, as in every other case, soon drove out the few white hands still employed. For a number of years the factory then was almost with Chinese labor, of whom, at certain times, upwards of six hundred were employed. Nothing but burlap for bagging was manufactured, and years when its manufacture yielded even a small profit, were the exceptions. In due course of time the stockholders grew tired of the losing investment, and just about the time when the State was going to invest in jute machinery for the State Prison, the Oakland concern shut down.

Strange to relate, where private enterprise had not succeeded, public enterprise did. The jute mill at San Quentin became a comparative success, and with this success came attempts to grow the raw material also. Here the same difficulty was met with which stares the advocates of silk culture in the face. It was easy enough to grow the plant, but the problem was to prepare it for the spinners. Jute, like flax and other fibrous material, requires certain preparation, and this preparation involves a character of labor which cannot be done by any machine so far invented. In India this labor is done by hand, and as labor there is extremely cheap, it follows that it will always be cheaper to import prepared jute than to grow it in this State, unless a machine be invented which would perform the labor more cheaply than it is now done by hand in East India. Those who experimented with jute and ramee in this State soon discovered the obstacles and abandoned their attempts for the time. The works at San Quentin continued to operate on the imported jute, and with the exception of the time when differences with the contractors for jute have left the institution without a supply of raw material, the establishment has been running with good success.

Those whose fortune had been embarked in the Oakland concern also took heart once more, and during 1883 a reorganization of that company was effected. New capital was put into the enterprise, and a new start made. The mill was fitted to make something else besides bagging, for machinery to manufacture matting, carpeting, rugs, etc., was added to the plant. The management further decided to get rid of Chinese hands as much as possible, and white boys and girls were given the preference whenever it could be done. It was a commendable undertaking and met with the success it deserved. The new class of goods manufactured met with a ready market, and within a few months the concern was on a firm basis.

Looking for further opportunities to extend the industry, the company next conceived the idea of attempting the manufacture of flax straw into textile fabrics. There are raised annually in this State, and in the neighboring State of Oregon, many tons of flax, the seed of which is the only part used, the straw out of which linen is manufactured, being permitted to rot in the field, or burned. Here, also, the difficulty is one which involves a labor problem. The flax straw also has to undergo certain processes, to be done by hand labor, which can be done in Europe so much more cheaply that the linen-making industry has never yet found a foothold in the United States. The Oakland company got a set of flax machinery, nevertheless, and succeeded in getting quite a quantity of flax pulp from Oregon. It seems that the operation paid fairly, for in this case the high rates of freight acted as a sort of a protective tariff, enabling the company to pay enough for the pulp to make the speculation reasonably profitable to the Oregonian. Further developments in this direction are awaited with interest.

It is all important to note that, according to very reliable reports, an eminent eastern machinist has just discovered a new method of preparing jute flax, ramee, or cotton fibers for the mills in so short a period of time, and at so small an expense, as to do away at once with the only obstacle which heretofore has prevented the successful establishment of the linen industry and of flax culture. This newly discovered process has become known as the "Tappan bleaching" process. Its merits are now being tested.

BORAX WORKS.

Another industry which promises well for California is the distillation and concentration of borax. The recent revision of the tariff has given additional protection to this branch of our local products, and under the beneficent influence of this change, there have been formed quite a number of new companies, nearly all of which are now engaged in active operations. Hitherto the difficulty has been that the borax fields were generally found in remote places, thus adding to the cost of concentration that of carriage to market, thereby often increasing its first cost by one hundred per cent. But the extension of railroads is slowly remedying this defect, and as the demand for California borax increases, new fields will become opened and available. The business has always been on a fairly paying basis, and being well controlled, will no doubt remain so. It is, however, capable of great extension.

WOOLEN GOODS.

One of the earlier industrial enterprises in this State was the manufacture of wool into blankets, cloth, etc. The industry has met with varying fortunes and if not always as profitable as might be desired, it has generally yielded a balance on the right side of the ledger. California has always been a producer of choice wool which ranked high in the markets and of which but a very small portion was manufactured into goods at home, the greater quantity going east. It is true that during late years there has been a steady decrease in the quantity of wool raised in this State, there being a steady decrease in the number of sheep pastured. But the quality of the wool has changed but very little, and for certain purposes it is as much in demand as ever and at prices which are relatively as high as ever. The wool industry is, however, affected by a cause over which the State Legislature has no control—that is the tariff, the recent change in which in regard to wool is claimed to affect the American wool grown adversely. It is a national question to which this bureau has not been able to give much attention and which it will not attempt to discuss on that account. It is mentioned here only because it is given as the cause of the depressed condition of the wool market all over the United States during the greater part of 1883 and 1884, and which affected California wool growers and manufacturers quite as much as those of other States. In fact it is claimed that the woolen mills have had a hard road to travel during the past year especially, and that an overstocked market and low prices have left little encouragement to the growth of the industry. Fortunately, the quality of California made woolen goods has always been as high as their reputation, and for this reason they have managed to retain their own market, that our woolen mills have suffered less from the depression than those of other States. Nevertheless it has been sufficient to prevent any decided extension of the industry. For instance, the town of Gridley made active preparations to establish a woolen mill, until upon a canvass of the situation it was found to be a risky undertaking at this time. The idea has been temporarily abandoned. A number of Napa capitalists also agitated the question of a woolen mill, and less conservative than the Gridleyites they have gone ahead and invested in a one-set mill. In addition the Petaluma woolen mill has also started up again and is reported to be fairly prosperous.

There are some peculiarities connected with the California woolen business. One is, that our people prefer eastern goods, full of shoddy, but of brighter patterns, to the homelier but more durable and serviceable patterns. Consequently, the local mills find little encouragement to fabricate worsted and cassimeres, and restrict themselves chiefly to the manufacture of blankets, which have a national reputation. It has also been suggested that if some of our mills would manufacture the wool now going east in its raw state, into yarn, the latter would find a market as readily as the wool itself, and yield a greater profit; but so far no one has thought well enough of this advice to give it a trial. Neither has an attempt ever been made to manufacture carpets, although all who have studied that question agree that, barring the difficulty of getting new and fashionable designs at a place so far away from where fashion makes its decrees, there is no country which is more advantageously situated than California for the purposes of carpet manufacture, the wools of several other countries being at our disposal, and within easy reach for this purpose.

FLOURING MILLS.

No business has changed more completely and few have been extended more widely in the past few years. As a wheat-growing State, the flouring interest is one of importance to California. Hitherto we have been content to raise the cereal and ship it out of the country on English bottoms, and in foreign made sacks. The business was almost entirely in the hands of foreign merchants, who made the local wheat market depend upon that of Europe, and whose first and greatest care was to see the ship owner well protected. It is so yet to a very great extent, although momentarily the field is not as inviting for foreign vessels as it has been. But it is owing chiefly to the high rates of freight demanded by ships, that flouring mills have multiplied and that old established ones have been enlarged, and it is equally true that the present depressed condition of the ocean freight market is responsible for the setback under which this industry is now suffering. For when ocean freight was high, thus keeping wheat values low, our millers being able to purchase their wheat cheap, could place upon the markets of Utah, Colorado, Arizona, and other Western States generally supplied by Chicago and St. Louis, flour at a much cheaper rate than the millers of those cities. When, however, the freight situation here became reversed, and freights went down to nominal rates while the price of wheat went up, this inland trade was lost again, and it is this loss from which the milling business has been suffering somewhat during the past year and a half. However, high freight rates encouraged also the foreign flour trade. The reduction of wheat into flour bringing also a reduction of bulk by one third, the saving on freight was sufficient to make up the enhanced cost of local milling. Consequently, much more flour was exported to Europe than ever before; and as the business paid, our millers made preparations to supply the demand. Nearly all the larger mills in the State adopted new processes of manufacture, and several new mills were created, while others were extended and enlarged. The capital invested in the business nearly doubled within three years, and it has now become so well established that ordinary periods of depression and dullness cannot affect it materially.

It is desirable for many reasons that the grain which California grows should be manufactured into flour before it leaves the State, all of which are too obvious to need to be pointed out here. The business is capable of much greater extension than it has yet attained, for probably but one tenth of the annual yield of wheat is converted into flour at home. The bringing about of this extension must be left to individual enterprise.

BEET SUGAR.

One subject which has engaged the attention of the thoughtful to a great degree is the beet sugar industry, which has found a limited foothold in this State. There is one refinery for beet sugar at Alvarado and it is mainly at the suggestion of its owners that a number of farmers have undertaken the cultivation of the sugar beet. There is also another mill at Isleton, on the Sacramento River. The enterprise was the more commendable as the growing of the plants in many cases was in the nature of experiment only, the matter of the proper soil and cultivation having to be carefully studied. Then, also, the crystallization of the price of beets grown in strange soil and under new conditions presented many difficulties which had to be removed. However, they were all overcome and it may now be unhesitatingly announced that the beet sugar industry is a financial and economical success that promises largely to add to the resources and the wealth of the State. Experience has shown that beet sugar can compete successfully with protected Hawaiian Island sugar even when the latter reached the lowest market value which it has ever been known to attain.

Closely allied to beet sugar is the sorghum industry. I am not aware that any attempts have been made in this State to grow the vegetable. Experiments in other States were successful for the first time in 1882, the difficulty up to that time being the impossibility of polarizing the saccharine matter. Our State Board of Horticulture looks with favor upon the introduction of sorghum culture and I know of no reason why I should not join my recommendation to theirs. It can only assist in driving out of the market the sugar produced by coolie and serf labor on the Hawaiian Islands.

FLINT GLASS WORKS.

I will conclude this brief review of recent industrial development with alluding to the latest addition to the list of enterprises successfully established in this State, the flint glass works, erected by the San Francisco and Pacific Glass Works in this city. The commoner kinds of glassware, such as bottles, etc., have been manufactured in this State for some years, but all finer goods had to be imported from the East. The enterprising business man who determined to make our State independent in this respect also brought twenty-six skilled mechanics to California and erected his works. It is a pleasing fact to add that his venture has proved successful, and that although at this writing the works have been in operation but a few weeks, the doubt of financial success seems to have been already dispelled. The new works are capable of turning out all kinds of flint glassware, useful as well as ornamental.

CHAPTER IV.

DESCRIPTIVELY THE STATE BY COUNTIES.

In the present chapter will be found a comprehensive description of the State, considered by counties. In every case the area, geographical and topographical features, agricultural condition and possibilities, products and means of inter-communication, will be found clearly presented, the information afforded being that obtained from the most reliable sources. To the resident such information is always interesting, while to the intending settler it should be particularly valuable and instructive.

It will be observed that the counties are not arranged alphabetically, but are grouped according to the great natural divisions of the State. These natural divisions are the great valley region, including the level plains, watered by both the Sacramento and San Joaquin Rivers; the lower foothill region, that is the rolling lands of the Sierra Nevada and Northern Coast Range; the mountainous region of the Sierras; the Coast Range region north of San Pablo Bay; the Coast Range region south of San Pablo Bay; and finally, the southern and desert regions.

GREAT VALLEY REGION,

Embraces the following counties and parts of counties: Butte, Tehama*, Colusa, Yuba, Placer*, Sutter, Yolo, Solano, Sacramento, San Joaquin, Contra Costa*, Stanislaus, Merced, Fresno, Tulare, and Kern.

BUTTE.

Area, 1,720 square miles. Sacramento Valley, 595 square miles (treeless adobe lands, 70 square miles); lower foothills, 965 square miles; higher foothills, 160 square miles.

Butte County is separated in part from Colusa on the west by the Sacramento River and Butte Creek; these streams receiving the drainage from the western half of the county. Very near the heads of these small tributaries, and flowing in a general south but irregular course, is Feather River, whose tributaries are all on the eastern side. The surface of the county thus has the general appearance of two successive plains, both sloping westward; the one on the east, or the foothills, is broken and rolling, and has Feather River at its foot; the second, or the plains proper, rises rather abruptly from this river, and slopes gradually and with a more even surface to the Sacramento River on the west. A large part of the latter plain, forming a belt

* In the lists of counties placed at the head of each group the names of those described *elsewhere* are marked with an asterisk (*); and the reference to the head under which they are described will be found in its place in the order of the list in the text itself.

from 12 to 20 miles wide along the Sacramento River and through the country, is quite level, and is embraced in the great valley region. It is the chief farming portion of the county. Its surface is treeless, and its lands vary from the rich sandy loam of the rivers to the stiff black and gray adobe, which is underlaid by limy hardpan, at depths of from one to several feet. A large adobe tract lies between the railroad and the alluvial lands of the Sacramento River, and is liable to overflow in wet seasons. These lands are said to yield an average of 30 bushels of wheat or 45 bushels of barley per acre. The adobe lands are bordered on the east by a light reddish loam, which is considered an excellent fruit and wheat land, and at some points bear an oak growth.

The line separating the valley from the foothills is said to be well defined, the surface of the latter being not only undulating and broken but barren and stony, with an abundance of bowlders. This line passes about 3 miles east of Chico, and a short distance west of Oroville, into Yuba County on the south. A belt of red land lies near the foothills. The lands of the foothills region are generally of a red and gravelly clay character, destitute of trees, and on the hills are barren. The valley soils are better adapted to farming purposes. There is a belt of 8 or 9 miles in width, within the western portion of the foothills region, in which the soil is thin and apparently derived from eruptive rocks. This belt in some places has an elevation of 1,000 feet above the plain.

The northeastern and eastern parts of the county are broken with ridges and hills between the creeks, and are well timbered with pine, cedar, and spruce. Turpentine and resin are obtained from the pine forests. The county is comparatively well populated and under cultivation, the average being 10.8 persons and 177.1 acres per square mile.

The Oregon division of the Central Pacific Railroad connects the county with Sacramento on the south.

TEHAMA.

(See "Lower Foothills Region.")

COLUSA.

Area, 2,500 square miles. Sacramento Valley, 1,275 square miles (including adobe, 100 square miles; tule land, 140 square miles); lower foothills, 580 square miles; coast range, 645 square miles.

Colusa County lies in the western part of the great Sacramento Valley, the Sacramento River, in part, forming its eastern boundary. Its western boundary line lies upon the summit of the Coast Range. The western third of the county is hilly, broken, and partly mountainous, and the general surface, falling eastward to the level valley lands of the Sacramento, is interspersed with narrow valleys along the many small streams that flow eastward; Stony Creek, the largest of these streams, flowing northward and northeastward until it escapes from the foothills, when it turns eastward toward the Sacramento. That portion of the great valley north of Jacinto has a gradual fall to the Sacramento River, and its lands are chiefly a reddish gravelly loam, quite similar to that of the foothills. The rest of the valley, or the part south of Jacinto, has a gradual fall to what is termed the basin, or "trough," a low, trough-like depression, partly of tule lands, lying 3 or 4 miles west of the river, and receives the waters of the western streams. From the basin to the river there is a rapid rise, and eastward of the river a fall to another basin or depression of Butte Creek; so that the river has the appearance of flowing along the summit of a low ridge. The lands of this river section between the basins comprise the rich alluvial loams that in other counties southward form so prominent a feature of the valley, and have a natural timber growth of cottonwood, sycamore, and ash.

The tule lands along the sloughs in this county are estimated to cover about 30,000 acres, and are excellent meadow lands. They are low, flat, and ill-drained, and are generally regarded as unproductive or irreclaimable, though crops of grain and cotton have been raised on them after proper drainage and protection by levees from the overflow of the river and other streams. The high land between Sycamore and Dry Sloughs is called Mormon Basin, and embraces rich lands, which yield about 50 bushels of wheat per acre.

The great valley (which includes also the tule and river lands) is a broad, level plain, open and almost entirely destitute of trees, and to the foothills has a width west of the river varying from 15 to 20 miles. The soil is chiefly a loam or sediment from the hills; that from one mile north of Willows to the Tehama County line being reddish and gravelly in character. These valley lands are largely in cultivation, and yield large crops of wheat, the principal crop of the county. Much alkali land occurs in spots in the region lying between the two tule land belts east and southeast of Williams. The small streams have shallow valleys, with silty or sandy alluvial soils, and are separated from each other by low ridges of brownish-gray adobe, which is often humpy or hog-wallow in character, and has more or less alkali in the depressions. These are called "goose lands." W. S. Green, of Colusa, says of this land: All the creeks that run from the foothills in Winter run on ridges. Between these ridges we sometimes have low flat land, with imperfect drainage, so that the water chills the soil; and as it goes off by evaporation, it leaves all the salts near the surface, and when entirely dry, it is more or less incrusted with alkali. In Winter there are ponds on this land around which the geese congregate, and as it was considered worthless for anything else, it was called "goose land." It is now found, however, that drainage and cultivation improve this land, and a great deal of what was called "goose land" now produces good crops.

The foothills which lie between the valley and the mountains, and become more and more broken westward, are partly covered with an oak growth and partly with brush, chamisal, and laurel. The hills are chiefly devoted to grazing purposes, and their lower valleys embrace almost the only farms of the region. The low hills, capable of cultivation, are thought to cover about 700 square miles, while the estimated area of the foothill valleys is about 200 square miles. Of the latter, Bear Valley, within 2 miles of the Lake County line, has a width of from 1 to 2 miles, and a length of 10 miles, its elevation above the plains being about 1,000 feet. There are some wheat farms in the eastern part of this valley, but the western portion is hardly under cultivation.

The upper part of Cortina Valley also is rough and unproductive, while the lower, near the plains, is of a better character, and is partly under cultivation.

Indian Valley, in the northwestern part of the county, has a length north and south of about 30 miles and a width of 5 miles on the north, but becomes very narrow on the south.

The soil of the foothills is red and gravelly, more or less rocky, and is especially adapted to fruits. The mountains of the coast range are too high for farming purposes. Pine is their chief timber growth.

The lands of Colusa under cultivation average 261.2 acres per square mile, the county ranking as ninth in the State in this regard. The average of population is but 5.2 persons per square mile. The California Pacific Railroad connects the county with San Francisco and Sacramento.

YUBA.

Area, 700 square miles. Sacramento Valley, 285 square miles; lower foothills, 415 square miles.

Yuba is a comparatively small county, and lies on the eastern side of the Sacramento Valley, reaching from Feather River northeastward to the foot of the high Sierra. Its extreme western part, bounded on the south by Bear River, is intersected by Yuba River, and is largely included in the great Sacramento Valley. The country embraced in the angles formed by the junction of these two streams with Feather River, the western boundary, is very level, and is intersected with small streams or sloughs. Along the rivers the lands, though formerly much above high water, are subject to overflow, the mining debris from the hills having in late years so filled up the channels as to cause the waters to spread out over the adjoining bottoms at every slight rise. These lands, once the richest in the county, are now so covered with this debris, or slickens, as to be "only a swamp of willows, cottonwood, and vines; a waste where bars of white sand and pools of slimy water glisten through the saplings. At high water the thick and muddy waters of the river are spread out over a wide region of level country, sometimes a mile or even three miles wide, once the richest farming lands of the region, but now deserted, leveed in, and covered with mountain mud, sand, and pebbles." Marysville is now surrounded by levees so high as to preclude a view of the surrounding country, giving it the appearance of a walled city of the Old World.

The great valley in this county passes about 10 miles east of Marysville, and southeast to the corner of the county. Its surface is quite level and treeless, with its soil well adapted to the culture of small grain, and is the chief farming portion of the county.

The foothills region, which reaches from the valley eastward nearly, if not quite, to the county limits, is at first rolling, but becomes more and more hilly, brushy, and rocky as the Sierra mountains are approached. Small valleys occur among the hills, but the lands are as yet but little under cultivation. The soils of the foothills are red and pebbly clays, and in the lower portions are well adapted to fruits and grapes. The northeastern part of the county is rugged and broken. The farming portion of Yuba County is estimated to embrace not more than one third of the total area, the remainder being devoted to grazing and mining purposes.

The lands of the county under cultivation average 158.3 acres per square mile, while the population has an average of but 16.1 persons.

The Oregon Division of the Central Pacific Railroad connects the county with Sacramento on the south.

PLACER.

(See "Lower Foothills Region.")

SUTTER.

Area, 580 square miles. Sacramento Valley, 530 square miles (including tule lands and some adobe); buttes, 50 square miles.

Sutter County, bounded on the west by the Sacramento River and on the east in part by Feather River, lies entirely within the eastern part of the great valley of that river, its eastern boundary line not reaching even the foothill region of the Sierra mountains. Between the two rivers, with the exception of Butte Slough, in the southeastern part of the county, there are no streams, the country being apparently without drainage. Bear River and several creeks flow westward, but disappear before reaching the rivers.

The surface of the country is very level, the only exception being a region in the northwest having a diameter of about 12 miles, in which appear a number of high, prominent, and craggy isolated peaks, or buttes, of basaltic rock, rising more than a thousand feet above the open plains, whose northern sides only are covered with a scrubby growth of oaks and pine. The border of this region consists of low, rolling foothills, whose lands are mostly devoted to pasturage. On the north and east are meadow lands, embracing, it is thought, about 10,000 acres, naturally subject to overflow, but largely reclaimed; while on the south and west there are marshes and tules, which extend southward in a belt several miles wide, nearly bordering the Sacramento River, through the length of the county. The drainage of these hills is through Butte Slough, at their southern foot, which also, in time of high water, connects the Sacramento and Feather Rivers. The immediate river lands of both the Sacramento and Feather Rivers are alluvial loams, timbered with a growth of cottonwood and sycamore, which, with the exception of some scattering oaks on the plains, is the only timber of the county.

The lands of the Sacramento River are highly productive, and largely under cultivation, as are also those of other smaller streams, while in the case of Bear and Feather Rivers the originally rich alluvial lands on each side of the river for a width of 1½ miles have been to a great extent covered with a slickens deposit of two or more feet.

The lands of the rest of the county are mostly dark loams, with some red gravelly clays on higher spots, yielding in their original condition an average of 25 bushels of wheat per acre. Stiff adobe tracts extend both north and south for some distance from the foot of the buttes, and occur in the low grounds south of Yuba City, and along the tules, and are said to yield from 30 to 40 bushels of wheat per acre.

The lands of Sutter County under cultivation average 296.3 acres per square mile, the county ranking fifth in the State; the average population is 8.8 persons per square mile. The Oregon Division of the Central Pacific Railroad runs through the county to Sacramento, on the south. The Sacramento River is also navigable for boats from Marysville southward, and furnishes transportation facilities to Sacramento and San Francisco.

YOLO.

Area, 940 square miles. Sacramento Valley, 610 square miles (including tule land, 250 square miles); lower foothills, 170 square miles; Coast Range mountains, 160 square miles.

Yolo County is bounded on the east by the Sacramento River, and on the south in part by Putah Creek, which rises in the hills of the Coast Range. Its surface is drained by but few streams, and of these Cache Creek, in the middle, is the most important. This creek enters the county from Clear Lake, on the northwest, flows eastward through narrow cañons for 12 or 15 miles, thence southeast through the broad Capay Valley to Langville, whence it turns eastward through the more level lands and plains to the tule lands, and disappears before reaching the river. Water for irrigating purposes is supplied from this creek by ditches to a large region of farms on either side.

From the Sacramento River westward across the tule and the level plains the surface of the country rises to the lower hills of the Coast Range, which appear abruptly along the western border, rising to about 1,500 feet above the sea. The county thus possesses the soil varieties usual to the country lying between the Sierra and the Coast Range mountains.

The tule lands in the eastern part of the county, with a width of from 5 to 10 miles, are separated from the river by a narrow belt of bottom lands having originally a rich alluvial soil, but now covered with a thick deposit of mining debris, brought down from the foothills. A part of this belt is known as Grand Island. The timber growth of both this and the bottom land of Cache Creek is chiefly cottonwood, sycamore, and willow.

Westward from the tule lands the surface for many miles is very level, comprising a part of the great plain, with its very deep and rich alluvial loam, and is mostly under cultivation in grain and fruits. The central part of this region, from a short distance south of Woodland for several miles to the north and west, is timbered with wide-spreading oaks, while the rest of the plains, and even of the county, is comparatively treeless. In the northern part of the county the plain is limited on the west by a line of low hills, lying about 3 miles west of the railroad, and reaching from the northern boundary south to Cache Creek, the extreme southern point appearing on the south of the creek about 4 miles from Woodland, and covering there an area of 2 or 3 square miles. This belt is 3 or 4 miles wide and is all well adapted to cultivation, the soil being a dark gravelly loam interspersed with tracts of red land. It is not timbered and to the northward, in Colusa County, it flattens out, and has a gravelly soil, with a stunted growth of white oak and chamisal.

On the west of the belt is what has been termed a hollow, or Fairview Valley, some 2 or 3 miles wide, reaching south to within a mile of Cache Creek, and embracing fine wheat lands. This valley is separated from Capay Valley on the west by the low Coast Range mountains.

The country south of Cache Creek is mostly a level and treeless plain (excepting around Woodland), and its soils are dark loams, nearly all under cultivation. A belt of adobe lands, somewhat lower than the plains, reaches from Madison, near the foothills, eastward within one and a half miles of Cache Creek and 8 miles south of Woodland; "it has a width of a little more than a mile, and forms a drainage sink from the cañons of the mountains to Willow Slough."

The county has an average population of 12.5 persons per square mile, while the lands under cultivation comprise 46.3 per cent of the area and average 296.6 acres per square mile, thus placing the county fourth in rank in the State, and but very little ahead of Solano and Sutter. It is one of the raisin-making centers of the State.

The county in connected with Sacramento and San Francisco by railroad.

SOLANO.

Area, 940 square miles. Sacramento Valley, 625 square miles (including tule land, 205 square miles); Coast Range mountains, 315 square miles.

Solano County forms the southwestern end of the Sacramento portion of the great valley, which occupies the eastern part of the county. The western boundary lies in part along the Coast Range, whence the surface gradually slopes eastward, southward, and southwestward.

Putah Creek forms the northern, and Sacramento River the southeastern boundary, while within the county there are but few creeks of any importance.

The county embraces tule lands along the bay and streams, a level and open treeless valley over its eastern part, and a rolling foothill region over the western, the latter including rounded and prominent hills with intermediate valley of rich clay soils. The hills and valleys are treeless, and very little timber is found anywhere in the county. The lands have been classified by the county tax assessor as follows: First class, agricultural lands for fruit, 50,000 acres; second class, for grain, 250,000 acres; third class, reclaimed swamp and overflowed lands, 200,000 acres; fourth class, partially reclaimed swamp and adjacent uplands having an alkali soil, 75,000 acres; fifth class, swamp and overflowed lands, and high and unproductive mountain ranges, the remainder.

One of the most prominent agricultural features of the county is what is known as the "Vacaville fruit region," reaching from Vacaville north to Putah Creek, and embracing Vacaville and Pleasant Valleys and the adjoining foothills, its length being about 12 miles, and its width from 1 to 3 miles. Vacaville Valley slopes from the hills in a south and southeast course, while Pleasant Valley slopes northward, each opening out into the Sacramento plain. A part of the region is in what is known as the thermal belt of the Coast Range, a location of a few hundred feet above the Sacramento plains, and above frost limits. The southern part of the region is cut off from Suisun Bay on the south by the Montezuma Hills, a succession of low, rounded hills, which extend eastward beyond the railroad. They have chiefly an adobe soil, partly under cultivation in wheat. There is some adobe land around Vacaville, but otherwise the soils of the belt are a dark loam.

Green Valley, north of Benicia, is about 11 miles long and 5 miles wide, and is bordered southward by high rolling uplands, which at some points fall off steeply into Suisun and San Pablo Bays. Mare Island, the site of the United States Navy Yard, is opposite the thriving town of Vallejo, and is separated from the mainland by Napa Slough. Its southern end presents a bold and rocky headland, projecting into the bay, and falling off gradually to the northward into a broad expanse of tule lands. The valley lands around Vallejo are partly adobe, while those of the adjoining hills are dark sandy loams; light colored calcareous clays underlie some of the lands.

The foothills of the county are partly covered with a scattered growth of oaks, horse-chestnuts, buckeyes, etc., and where not too steep or broken are partly under cultivation.

The lands of the Sacramento Valley, or eastern portion of the county, are the dark loams, often adobe in character, belonging to the higher portions of the great valley. These lands are almost treeless and very level, and are cut occasionally by arroyos or ravines. The greater part is under fence and cultivation, the chief crop being small grain. The lands of Putah Creek valley embrace *low* and *middle* lands of rather stiff loam soils, and *highlands,* lighter in character, and two or three feet above the latter. The average population of the county is 19.6 persons, and that of lands under cultivation 296.3 acres per square mile. In the latter regard the county ranks as fifth in the State, and this average is the same as that of Sutter, and but three tenths of an acre below that of Yolo.

Transportation facilities to San Francisco and Sacramento are afforded the county by the California, Pacific, and Northern Railroad, which passes through from east to west, and by a branch road from Elmira to Vacaville and Winters on the north. Ships also can reach Benicia and Vallejo through the bay and receive their cargoes of grain direct from the warehouse at these points.

SACRAMENTO.

Area, 1,000 square miles. Sacramento Valley, 935 square miles (including tule land, 245 square miles); lower foothills, 65 square miles.

Sacramento County is bounded on the west by the river of the same name, and on the south in part by the Mokelumne River, and lies almost entirely within the great valley.

The American and Cosumnes Rivers are the two other most important streams of the county. These rivers rise among the mountains of the adjoining eastern counties, and flow southwestward, the former to the Sacramento River at Sacramento City, and the latter to the Mokelumne River on the south. Several creeks are tributary to these streams.

The county includes on the extreme east a belt of foothills from 6 to 8 miles wide, Folsom being on its western limit; but otherwise the surface has only gentle undulations, and is watered by streams flowing into the marshes of the tule lands, through which the waters reach the Sacramento River by many channels. "The main Sacramento River (also separating as it flows south into diverse branches or sloughs, some of which are very intricate), runs across the broad tule bottoms in crooked channels, cutting them up into numerous small and several large islands." Along the border of this river there is a belt of alluvial land varying in width from one half mile to a mile or more, originally timbered with cottonwood and sycamore, which is almost entirely under cultivation.

A lower region or belt of tule lands borders this on the east, which is quite narrow in the northern half of the county, but expands to a width of fifteen miles on the south. Portions of these lands have been reclaimed or protected from the overflow to which they are subject and are under cultivation, but the greater part is used as pasture land; thence eastward the surface gradually rises to the foothills, from whose spurs diverge broad low ridges of reddish loam soil, gravelly near the hills, alternating with swales, having a soil somewhat heavier and less deeply tinted, these undulations being perceptible far into the plain. When fresh, the lands of this plain produce thirty bushels of wheat per acre; they are, however, chiefly devoted to fruit culture.

Southeast of Sacramento, the red lands are underlaid by a porous and soft material at from two to six feet, and this by an impervious clay. The belt of foothills is rolling, interspersed with low hills, and its soils are red and gravelly clays, having a scattering growth of oaks. A few mountain spurs from the Sierras enter the county.

The lands of the county under cultivation average 304.6 acres per square mile, a number exceeded only by San Joaquin County. From the City of Sacramento railroads reach east, west, north, and south, and the river is navigated by steamers both above and below.

SAN JOAQUIN.

Area, 1,360 square miles. Great valley, 1,210 square miles (including adobe, 310 square miles, and tule land 320 square miles); lower foothills, 50 square miles; Coast Range mountains, 100 square miles.

The eastern portion of San Joaquin County lies in the foothills of the Sierra, while the extreme southwestern part rests upon the Coast Range mountains, the central and greater area being thus included in the great valley of the San Joaquin River, which stream flows northwestward, the Sacramento River forming the northwest boundary of the county. Other large streams, such as the Mokelumne, Calaveras, and Stanislaus Rivers, all flowing westward, drain the eastern part of the county, and several streams occur on the west. The surface of the country, with the exception of the two extremes mentioned, is quite level, and is dotted over with a scattering growth of white and a few live oaks as far south as French Camp Slough, beyond which there is but an open plain from the San Joaquin River eastward for 15 miles. The larger streams are mostly lined with a growth of cottonwood, willows, and sycamore.

This county, situated as it is at the point where the Sacramento and San Joaquin plains unite, or rather at the foot of each plain and in the center of the great valley, naturally possesses a variety in its agricultural features. The lands of each valley are to some extent represented, and we find on the west, along the rivers, a broad region of tule lands and marshes, on the east the foothill belt, extending through the county, while in the broad valley plain the alluvial loams of the Sacramento Valley reach southward nearly to Calaveras River, and the sandy lands of the San Joaquin Valley extend northward as far as French Camp Slough, the two being separated by a broad belt of black loam and adobe lands reaching from the foothills westward to the tule lands.

Tule Lands.—West of Stockton to the county line, and from a point some 15 miles south to the northwest corner, there is an immense tract of tule lands (estimated at 200,000 acres), through which the San Joaquin and Sacramento Rivers find their way in many channels to their junction and to Suisun Bay. Numerous islands occur in this region, but are subject to overflow from the rivers; they have rich soils, and when properly leveed are under cultivation. Roberts Island, with its area of about 67,000 acres, is the largest. Eastward the tules are not so low, and by a system of levees they have been largely reclaimed and are under cultivation.

The Valley Lands.—A strip of sandy alkali lands, with a width in places of about 1½ miles, borders the tules on the east. It is covered with salt grass and a scattering willow growth.

The northern part of the valley, from the county line south to within two miles of Calaveras River, has a sandy loam soil, quite deep, and is watered by Mokelumne River, whose wide bottom land is timbered with willows, sycamores, and oaks. The surface of the country is very level, gradually rising eastward to the foothills, and is dotted over with a growth of white and some live oaks. This growth is said to have been originally very dense, but the entire country is now under fence and has been cleared. As the foothills are approached, the lands become darker and richer, and form a plateau some fifteen or twenty feet above the river bottoms. The western part of this sandy loam country is the great watermelon region of the State, but small grain is produced abundantly. The eastern portion has been but recently furnished with transportation facilities by the building of the San Joaquin and Nevada Railroad.

The central portion of the valley, as has already been stated, is a black loam or adobe region, and forms the divide between the two great valley regions, reaching from the foothills westward to the tule lands of the rivers. Its surface is very level, dotted over with scattered white oak trees, is almost entirely under fence, and is largely under cultivation.

The northern limit of the adobe region lies 2 miles north of Calaveras River, eastward to the foothills; the southern limit is along French Camp Slough for several miles, and thence southeast to Farmington and Oakdale in Stanislaus County. The western part of the region has a width of about 10 miles, in the middle of which is the City of Stockton. The adobe soil is said to be from 5 to 10 feet deep, and is interspersed with tracts of a light loam, which yield about 30 bushels of wheat per acre. A strip of alkali land reaches from the border of the tules, near Stockton, northeastward to the Calaveras River, a distance of about 14 miles. Its width is from 1 to 2 miles, though within this belt it occurs only in spots or small tracts a few inches below the general level of the adobe lands, often covered with salt grass and entirely unproductive.

The southern part of the valley, or that portion lying south of French Camp Slough and west from the San Joaquin River to the black lands of Farmington, is level, sandy, and treeless, mostly unproductive unless irrigated, and is the extreme northern representative of the similar lands of the San Joaquin plains of the counties south. On the west of the river, to the Coast Range, and south of the tules, these sandy lands also occur, interspersed with much black adobe, and from lack of irrigation facilities are also uncultivated.

The *foothills* form a narrow belt within this county along the eastern boundary, the change being so gradual from the valley proper into the undulations that are first observed that the line of separation is with difficulty defined. Clements, Bellota, and Farmington are, however, near this line, which thus makes a curve eastward, and after passing Farmington, turns again southeastward into Stanislaus County. Its surface is rolling and mostly broken, its hills partly covered with trees and brush, and have red, gravelly soils; the valleys are mostly treeless, except along some of the creeks, and have soils varying from dark or light loams to red gravelly lands. Beds of rounded bowlders often fill the beds of the creeks. In the southern part of the region the red lands seem to predominate. This foothill region is but little under cultivation.

The county is comparatively well settled, the average being 17.9 persons per square mile, while in the percentage of lands under cultivation (52.8) it ranks highest in the State, with an average of 338.4 acres per square mile. Wheat and barley are the chief crops, and transportation is afforded by the Southern Pacific Railroad to San Francisco and Sacramento, as well as across the continent to the Atlantic States.

CONTRA COSTA.

(See "Coast Range Region, South of San Pablo Bay.")

STANISLAUS.

Area, 1,420 square miles. San Joaquin Valley, 925 square miles (including adobe, 100 square miles, and tule land, some); lower foothills, 140 square miles; Coast Range mountains, 355 square miles.

Stanislaus County lies across the valley of the San Joaquin, its eastern border being among the foothills of the Sierra, and its western resting on the summit of the Coast Range mountains.

The great valley, which thus occupies the central portion of the county, has a width of about 35 miles. On its western side the San Joaquin River flows northwestward, being joined on the east by the Tuolumne River, occupying the central part of the county, and by Stanislaus River, which forms in part the northern boundary, both having their sources among the mountains of the east. The western slope is drained by several creeks. The San Joaquin River is bordered by a belt of tule lands from 1 to 2 miles wide, while the adjoining lands, for a distance of from 1 to 5 miles on the east, have adobe valley soils, more or less interspersed with alkali soils and salt grass. The bottom land of the Tuolumne River is very sandy, while that of the Stanislaus is a dark and firm loam, bearing a luxuriant growth of grapevines among the oaks. This bottom is about 300 yards wide. The plains are very level and without timber growth, except narrow belts of cottonwood and oak along some of the large streams, whose bottom lands are generally quite narrow. The lands of the central part are sandy, especially south of the Tuolumne River, passing northward as well as westward into gray or blackish loams, from which there is a gradual transition to the heavier adobe soils of the immediate valley of the San Joaquin River, into which the plains fall off with a gentle slope and change to a brown sandy loam, sometimes with a deep orange-red subsoil, as they approach the foothills of the east. Oakdale is situated about 80 feet above the bed of Stanislaus River, in the northeastern part of the county, and in a region of black lands, which extend southward half way to La Grange. The lands are not uniform in character, but are interspersed with tracts of red soils, and the depressions often contain cobble stones. The last half of this foothill border region is undulating, and the soils are more generally a reddish loam.

The foothills of the Sierra extend but a few miles into this county, forming a narrow belt along the east, the soil of which is mostly a red clay, except on the north of Stanislaus River, or in the northeastern part of the county, where the lands are dark loams, with some adobe. An inferior pine growth is found in some places. The foothills of the Coast Range, on the west, are rolling and broken, and have a width of several miles. The soil is mostly sandy and is under cultivation to some extent in the valleys.

The mountains of the Coast Range rise to an elevation of over 2,000 feet, and are rough and much broken.

The crops of the county are chiefly wheat, barley, oats, and corn; the fruits comprise oranges, lemons, limes, pomegranates, olives, peaches, apples, pears, and almonds. Grapes and peanuts are also raised. The average yield of wheat is 15 bushels per acre when Winter-sown.

The county is not thickly settled, the average being but 6.1 persons per square mile. More than 45 per cent of its lands are, however, under cultivation, the average being 294 acres per square mile, thus placing the county seventh in the State in rank as a farming region. It claims to be the banner county for wheat production. The Southern Pacific Railroad passes through the central part of the county from northwest to southeast, and affords transportation to San Francisco and Sacramento, or to the Atlantic States.

MERCED.

Area, 2,280 square miles. San Joaquin Valley, 1,740 square miles (including adobe, 320 square miles); lower foothills, 20 square miles; Coast Range mountains, 520 square miles.

Merced County, with its eastern border lying along the edge of the foothills and its western on the Coast Range of mountains, is divided into two parts by the San Joaquin River, which flows nearly centrally through it in a northwest course, and to which the surface of the country slopes from either side. The chief stream of the county—besides the San Joaquin—is the Merced River, which, rising among the high Sierra, flows through Yosemite Valley and the foothills of Mariposa County, and westward across the plains of this county, in a valley bordered by high banks for the greater part of the distance, to the San Joaquin River. Dry Creek is one of its few tributaries. Bear Creek, on which the county seat is located, rises among the foothills of Mariposa County, and in its western course across the valley, flows between high banks for a large part of the distance. On the south of this stream are Mariposa and Chowchilla Rivers, the latter forming the southern boundary line. Besides these there are numerous creeks and sloughs, all flowing westward and disappearing in the plains before reaching the San Joaquin River. Similarly, in the western part of the county, there are numerous creeks tributary directly to the San Joaquin that have their source in the Coast Range, but are of no special importance, only reaching the river in time of flood.

The San Joaquin River, in its course through this county, is bordered by a belt of tule lands reaching from the southern boundary northward nearly to the mouth of Merced River, and having a width of several miles, though lying almost entirely on the west side of the river. The surface of the entire county—except along the large streams, which are bordered by a growth of oak—is treeless and presents great variety in its agricultural features. Immediately eastward of the San Joaquin River, there is a region of drifting white sand, reaching from the Stanislaus County line on the north, southward, nearly to Bear Creek, and eastward beyond the railroad, to the point where Dry Creek unites with Merced River, while still eastward along the river the soil changes to a sandy loam more or less gravelly.

The lands of the sand region are level, or rather rolling, the soil usually very deep, and has a vegetation of alfilerilla, some clover and tar weed, and occasionally some rattle weed. Wheat is chiefly cultivated, the yield being from 10 to 15 bushels per acre in ordinary seasons.

The lands of Bear River, from the foothills to its mouth, are chocolate-colored clays, more or less adobe in character, while southward to Mariposa River black adobe and hog-wallow lands prevail, and contain some alkali in that portion of the region partly covered with sand, which extends from the railroad westward to San Joaquin River. This region is a level plain to the very foothills. South of Mariposa River the lands of what is known as the Chowchilla region, embracing that creek and the sloughs that are connected with it, are sandy, and, in places, of such a character as to be called "sand mush." They are also largely alkali and hog-wallow in character, especially around Plainsburg and westward, where they are best suited to pasturage. Clover and alfilerilla (except on the alkali soils, where the salt-grass occurs), comprise the vegetation.

In the northeastern part of the county, and east of the sand region first mentioned, the country is rolling and partly hilly, the Black Rascal hills being embraced in a belt of black adobe, hog-wallow, and gravelly lands, reaching from Stanislaus County, a little southeastward, to Mariposa River, south of Bear Creek, its continuity broken by the sandy border lands of the two rivers. Its width east and west is from 1 to 2½ miles. The hills are from 100 to 200 feet in height, and are capped with about 25 feet of red gravelly clays, while on their sides and in the valley are the adobe lands, in whose swales, as well as in the creeks, there are cobble-stones.

This belt passes about 6 miles northeast of Merced, the county seat. To the eastward of the belt, and south of Merced River, the valley lands are red and gravelly to the foothills.

The Merced River Valley, which at Hopeton is about 4 miles wide, is bordered on the south by a line of hills some 50 or 60 feet above it, which extends westward, gradually falling in elevation, nearly to the railroad at Cressy. The adobe lands mentioned occupy the landward slope of these hills, and are found to be underlaid by a whitish fissured claystone, sandy and ferruginous, easily cut, and used for building low walls. The lands of this river valley are a sandy loam, interspersed with underground gravel ridges, which in many places spoil the lands for farming purposes. The soil of Dry Creek is light and reddish, very deep, and yields 25 or 30 bushels of wheat per acre. The uplands north of Merced River are sandy and in part more gravelly than on the south, and will yield from 20 to 25 bushels of wheat per acre.. Merced Falls is at the border of the foothill region, and here, as well as northward, are found partly metamorphosed slates standing almost vertically on edge. The foothills are sparsely covered with an oak growth, and their soils are chiefly red, gravelly, rocky, and rather stiff.

The crops of the county are chiefly wheat and other small grain.

Cotton is planted in the Merced River Valley quite extensively, and grows from 3 to 4 feet high, yielding an average of 1,200 pounds of seed cotton per acre, 100 pounds of which make 30 pounds of lint. The crop is irrigated once, usually in June; a later time would cause much new growth, while another irrigation causes the plant to run too much to weed.

The Robla Canal, carrying water from Bear Creek, is 12 miles long, and is said to have a capacity of 120 cubic feet per second.

The Farmers' Canal takes water from Merced River, 3 miles below Merced Falls; thence, its route lies along a rolling sidehill, through a tunnel 4,000 feet long, a distance of six miles to Canal Creek.

The bed of this creek carries the water for 13 miles further, and thence it is distributed principally on the plains between the river and the town of Merced.

The lands of the county are largely under cultivation, the general average being 121.7 acres per square mile, the county ranking thirteenth in the State in this regard.

The Southern Pacific Railroad passes through the valley region of this county from north to south.

FRESNO.

Area, 8,000 square miles. San Joaquin Valley, 3,520 square miles (including tule land, 250 square miles); lower foothills, 500 square miles; higher foothills and mountains, 3,060 square miles; Coast Range, 920 square miles.

Fresno, one of the three large counties that embrace the upper portion of the San Joaquin plains, reaches from the Sierra mountains westward across the plains to the summit of the Coast Range, the elevation on each side being, respectively, above 10,000 feet on the east, and about 3,000 feet on the west above the plains.

The plains extend westward to the foot of the mountains on the extreme border of the county, and are separated from the Sierra on the east by a broad region of foothills.

The lowest portion of the county is in the central part of the plains, from southeast to northwest, and embrace a belt of tule lands, marshes, and sloughs, extending from the border of Tulare County, on the southeast, to the point where the San Joaquin River makes its northwestward bend, and thence becomes the central feature of the valley. This river is the largest stream in the county. It rises among the mountains and foothills of the east, and flows in a westward course to the middle of the plains, thence turns northwestward towards the Sacramento Valley, and has along its immediate border a timber growth of cottonwood, sycamore, willow, and large oaks.

King's River, emerging from the cañons about 40 miles eastward from Fresno, flows in an irregular course southwestward, and traverses a region of undulating plains, until to the northward of Tulare Lake it enters the Mussel Slough region, described under the head of Tulare County. Ordinarily the waters of King's River, not diverted by the numerous irrigation ditches, enter Tulare Lake, but in time of high water they pass partially through Fresno Slough into the San Joaquin River. A number of creeks, rising in the foothills on either side of the valley, flow out upon the plains, but disappear before reaching the river. Numerous sloughs also occur.

The eastern part of the county is extremely rugged, the western face of the Sierra Nevada Mountains, as well as the higher foothills, being cut by tremendous chasms, through which flow King's, Fresno, and San Joaquin Rivers, and their tributaries. Some of the highest peaks rise to an altitude of more than 14,000 feet. An abundance of timber is found on the western slope of this mountain region, two large bodies of redwood being reported on the northeast and southeast. At the head of Fresno River there is a heavy growth of sugar and yellow pine, fir, big tree, and white cedar, with white ash in other places. The mountains of the west are partially timbered with oak and scrub-pine.

The foothills are rolling and broken, 20 or 30 miles in width, covered with scattered oaks, and are interspersed with high and prominent peaks and ridges. The narrow valleys of the streams alone are suitable for cultivation.

The plains possess a variety of lands. The greater portion, however, is a sandy loam, with no timber growth, and requires irrigation to be productive. On the western side of the river the plain slopes gradually from the Coast Range to the slough, and much of its land, even with irrigation, is said to be too poor and sandy for farming purposes. Along Fresno Slough, for several miles in extent, there is much alkali land. Much of the valley land is of an ashen character in color. The plains, with a whitish calcareous loam soil, extend eastward from the river to the railroad, beyond which the surface of the country rises a few feet to a slightly undulating plateau reaching to the foothills. This plateau is destitute of trees, and is traversed by low sandy ridges, which lie between the creeks, and from 15 to 20 feet above the level tracts adjoining the streams, or what may properly be called the general level of the plateau. These level lands have a brownish or reddish sandy loam soil, produced by the more or less admixture of the red foothill clays, and nearer the streams it is stiff enough to be locally designated as adobe. The ridges in the vicinity of King's River contain much white quartz gravel. The plateau region reaches from the San Joaquin River, near the railroad crossing, southward to 1 mile southwest of Fresno, and thence east to King's River.

On the west of the San Joaquin River the plains reach 20 miles to the foothills of the Coast Range, which forms a belt about 10 miles wide "of low hills, covered only with grass; thence to the summit the hills are more abrupt, covered with scrubby oak, and in many places with a dense growth of chaparral."

There are a number of colonies located within from 2 to 6 miles of Fresno City, and all of them are engaged in agricultural pursuits, and have their schools, churches, and social and literary societies. The county is sparsely settled, the average being but a little more than one person per square mile, while the lands under cultivation average 36.3 acres per square mile.

The crops of the county embrace chiefly wheat, barley, corn, oats, potatoes, and alfalfa; but there are numerous orchards and vineyards in successful cultivation.

Cotton has been grown, with an excellent yield, but the cost of production and the small demand makes it rather unprofitable. The Southern Pacific Railroad passes through the county from San Francisco on the north to the Atlantic States on the southeast.

From the great bend of the San Joaquin River two canals have been constructed, the Chowchilla and the San Joaquin and King's

River. The Chowchilla Canal has a length of about 30 miles, and lies on the east of the river, crossing in its course northward Cottonwood and Bereoda Sloughs, and the Fresno, Mariposa, and Chowchilla Creeks. Its capacity may be taken at from 200 to 250 cubic feet per second.

The San Joaquin and King's River Canal, lying on the west side of the river, reaches to Orostimba Creek, a distance of 67 miles, being longer than that of any other irrigating canal in the State. It commands an area of about 283,000 acres, which includes all the lands lying between it and the river, 130,000 acres of which are low, and naturally subject to overflow in seasons of ordinary flood. Its capacity is about 600 cubic feet per second. Another small canal, from the Fresno River on the south side, is used upon land within 9 miles of the headgates. Don Palos and Temple Sloughs have also been converted into canals by deepening and enlarging their channels.

In the southern part of this county there are a number of canals and ditches taking water from Fresno River. The King's River and Fresno Canal, from near the foothills, has a length of 22 miles, and supplies water to the scattered farms on the high plains north and east of the town of Fresno.

The Fresno Canal and the Irrigation Company's Canal takes water a mile below the head of the last canal, and conducts it to the immediate neighborhood of the town of Fresno. Its total length, with branches, is 63 miles.

The Centerville and Kingsburg Canal, 26 miles long, conducts water to Kingsburg. Besides these, there are several other smaller ditches and canals reaching to different parts of this county.

TULARE.

Area, 5,610 square miles. San Joaquin Valley, 1,775 square miles (tules, 30 square miles); lower foothills, 390 square miles; higher foothills and Sierra mountains, 3,245 square miles; Coast Range mountains, 200 square miles.

Tulare County, in common with the other two great counties of the San Joaquin Valley, embraces within its area high Sierra mountains on the east, which are 10,000 feet or more above the sea, a small region of low Coast Range mountains on the west, and a broad and low valley and foothills region between the two mountain ranges. A prominent feature of the county is Tulare Lake, a large body of water, 33 miles long and 22 miles wide, lying on the western side of the valley and having a somewhat alkaline water. This lake receives the drainage waters from the entire county, though many of the streams break up into sloughs and reach it through numerous channels. The chief of these streams are White, Yule, Kaweah, and King's Rivers. The creeks and sloughs are many in number and lie almost exclusively on the east.

The *mountainous region* covers more than one third of the county area and some of the peaks are the highest in the State, Mount Whitney being the highest on the Pacific Coast (15,000 feet).

The foothill region lying at the foot of the Sierra has a width varying from 9 to 12 miles. The surface is much broken with high and isolated hills and ridges, interspersed with many small valleys, which furnish the only lands suitable for farming purposes. Their soil is red, clayey, and gravelly. The lands of the *valley* are quite level and mostly destitute of trees. Visalia, the county seat, is situated in the Kaweah delta, a region of oaks, which extend half way to Goshen on the west, 15 or 20 miles southwestward, and several miles northeastward. The soils of the valley vary from a light sandy loam to a light adobe, and a large tract of highly productive, dark alluvial loam occurs in the Mussel Slough region, north of the lake, and reaches eastward from within one mile of King's River to Cross Creek, 6 miles from the Southern Pacific Railroad. Tule lands, sometimes of large extent, occur on the borders of the lake and along the various streams and sloughs. The lands of the county are too dry to be successfully cultivated without irrigation and ditches have been dug many miles long, from the larger streams, to furnish the necessary water. The chief crops are wheat, barley, corn, potatoes, and hay, but fruits, comprising apples, pears, peaches, and grapes are also raised. Lemons and oranges are grown in the foothills. Cotton, also, has been successfully produced in the country, the Matagorda variety doing best, and there seems to be little doubt that, with a demand for the staple and the erection of gins and mills, the crop would be made profitable.

Water has been obtained in artesian wells, near Tulare, at a depth of 295 feet, the flow being about 100,000 gallons in 24 hours and having a temperature of 70° F. Another well, at a depth of 330 feet, furnished nearly double that amount of water, and many more of similar yield have lately been obtained. This county is more thickly settled than Fresno, the average being two persons per square mile for the county at large. The lands under cultivation have an average of 35.7 acres per square mile, and are chiefly planted in wheat, barley, alfalfa, etc., the chief areas of production being the country around Visalia and the Mussel Slough country.

The Southern Pacific Railroad passes through the central part of the county, connecting with San Francisco on the north, and with the Atlantic States on the southeast A branch road extends westward from Visalia and to the Mussel Slough region on King's River.

From King's River there are six canals that take water below the crossing of the railroad and conduct it to the Mussel Slough country, their total length, with main branches, being 116 miles. There are also a number of small farm ditches, in the same region, taking water in the channels north. The region covered is about 155,000 acres.

KERN.

Area, 8,160 square miles. San Joaquin Valley, 2,590 square miles (tules, 290 square miles); lower foothills, 560 square miles; higher foothills and mountains, 1,955 square miles; desert lands, 2,180 square miles; Coast Range mountains, 875 square miles.

Kern is one of the largest counties in the State, and includes within its boundaries the extreme upper (southern) end of the San Joaquin Valley, as well as parts of the Sierra mountains and Mojave Desert on the southeast and south, and of the Coast Range of mountains on the southwest. The two mountain chains unite on the south, and thus form a high border of from 2,000 to 4,000 feet above the valley on all sides except the north, their spurs often extending far into the plains. The lower ranges and hills on the east and south are generally covered with grasses and shrubbery, and often with oak, pine, and fir trees. The mountain region of the west is said to be valueless for farms; that of the south and east, on the contrary, has numerous high valleys, which are largely under fence and to some extent in successful cultivation.

The Tehachapi Valley, through which the Southern Pacific Railroad passes, is about 12 miles long and 3 miles wide, surrounded by very high mountains, and in it there is a small salt lake. In this valley the yucca first appears, which afterward becomes so predominant in the Mojave Desert. Cumming's Valley, with a length of 6 and a width of 3 miles, and Bear Valley, 3 miles long and 1 mile wide, nearly adjoin Tehachapi. Abundant timber is said to be easily accessible to all of the mountain valleys.

The valley of the south fork of Kern River, 8 miles north of Havilah, contains about 40 square miles, and is well timbered. The surface of the plains is very level and treeless, and for the most part has a sandy loam soil, which, with proper irrigation, is quite productive. From Bakersfield eastward for 10 miles to the foothills and cañons of Kern River there is a strip of undulating country elevated above the valley proper and having a sandy loam soil. From Bakersfield southward a belt of tule marshes reaches the Kern and Buena Vista Lakes (themselves now little else than marshes, connected by a slough 100 feet wide), and thence northward to Tulare Lake, forming the outlet, in part, for the waters of Kern River. The lakes are gradually disappearing by evaporation, because of the shutting off of their water supply by irrigating canals. The waters are strongly charged with alkali, and are totally unfit for use.

Kern River Slough reaches from the north of Bakersfield westward toward the marshes, and forms, as it were, a "cut-off," the country thus included between it and the old channel and the marshes of the east, south, and west being a delta region of rich sandy loam, originally having a willow and cottonwood growth, and embracing the chief farming lands of the county, known as "Kern Island." Previous to 1875, this delta region, with the rest of the county, was considered almost worthless agriculturally, and was almost entirely uncultivated; but by means of an extensive system of irrigating canals, Messrs. Haggin, Carr, and Livermore have shown that the lands are highly productive, and large ranches of thousands of acres each are now under cultivation on this island. Irrigation is, however, absolutely necessary, and a network of ditches and canals from 2 to 20 miles or more long and from 20 to 150 feet wide, has been constructed, bringing the waters of Kern River into every portion of the county and carrying cultivation far into the plains. The following summary of irrigating canals is taken from the State Engineer's report:

District No. 1, between Old South Fork and Old River. Total area, 80,000 acres; number of canals, 5; aggregate capacity of canals, 895 cubic feet per second.

District No. 2, west of Old River and south of New River. Total area, 64,000 acres; number of canals, 9; aggregate capacity, 348 cubic feet per second.

District No. 3, between New River and Goose Lake Slough. Area, 70,000 acres; number of canals, 11; aggregate capacity, 1,924 cubic feet per second.

District No. 4, swamp lands south of Tulare Lake. Area, 103,000 acres; number of canals, 2; aggregate capacity at head, 3,370 cubic feet per second.

District No. 5, north of Kern River and Goose Lake Slough. Area, 360,000 acres; number of canals, 6; aggregate capacity, 645 cubic feet per second.

Total number of canals and ditches, large and small, 33; total length of main canals and branches, 275 miles. From the Kaweah River there are 16 canals; two carry water to the Mussel Slough region, the others to the region of Visalia.

Many artesian wells have been successfully bored on the north side of the two lakes, water being obtained at depths of from 200 to 300 feet. The artesian belt, as developed by the wells, has a length of about 18 miles and a width of 6 miles.

The principal ranches are the Livermore, about 12 miles south of Bakersfield, and the Belleview Ranch, about 18 miles southwest, along Kern and Buena Vista Lakes, each including about 7,000 acres, and nearly all under cultivation. From Fort Tejon, on the southern extremity of the county, to Kern River, a distance of about 40 miles, along the western border, the county for 10 miles from the Coast Range of mountains is covered with salt marshes and brine and petroleum springs.

The county is sparsely settled, the average being much less than one person (six tenths) per square mile, while the average of lands under cultivation is 7.5 acres per square mile. The crops embrace wheat, barley, corn, etc. Cotton also has been raised successfully, but the want of a market has made its production less remunerative than other crops. Transportation facilities are afforded by the Southern Pacific Railroad, which passes through the county, connecting with San Francisco on the north and the Atlantic States on the southeast.

LOWER FOOTHILLS REGION

(*Of the Sierra Nevada Mountains and the northern Coast Range.*)

(This embraces the following counties and parts of counties: Of the Coast Range foothill counties—Shasta, Tehama, Yolo,* and Colusa;* of the Sierra foothill counties—Shasta, Tehama,* Plumas,* Butte,* Sierra,* Yuba,* Nevada, Placer, El Dorado, a little of Sacramento,* Amador, a little of San Joaquin,* Calaveras, Tuolumne, a little of Stanislaus,* and Merced,* Mariposa, Fresno,* Tulare,* and Kern.*)

SHASTA.

Area, 4,000 square miles. Lower foothills, 1,525 square miles; higher foothills and Sierra mountains, 1,950 square miles; Coast Range mountains, 525 square miles.

Shasta County, situated at the head of the great valley drained by the Sacramento River, is one of the best watered counties in the State. The river has very many confluents, both from the mountains of the Sierra on the east and north, and from the Coast Range on the west, all uniting near the southern border. Chief among these, is Pit River, whose source is in the northeastern corner of the State.

The mountains that cover a large portion of the county on all sides but the south, are rugged and lofty, rising more than 5,000 feet above the sea. On the east there are four peaks of special prominence that stretch far into the county from the Sierras, separated from each other by distances of 10 or 12 miles. Lassen's Peak, the highest of these, having an altitude of 10,577 feet, and timbered for two thirds of the way up, the rest being bald, and usually covered with snow. Other peaks and buttes occur everywhere, and all are of volcanic origin, as shown by extinct craters, cones, sulphur deposits, beds of lava, etc. Hot and boiling springs are also of frequent occurrence. The mountains of the north and west parts of the county are covered with forests of conifers of nearly every variety, except redwood, while on the lower hills, live oak is abundant, and ash occurs along the streams.

The southwestern portion of the county, embracing about one third of its area, is a foothill region having an altitude of not more than 2,000 feet above the sea. Its surface is hilly and broken, and is interspersed with numerous valleys along the several streams.

The tillable lands are chiefly east of the Sacramento River; a broad region, comparatively level, lies between that stream and Stillwater and Cow Creeks, a distance of about 12 miles. The river itself from Redding south to the county line is bordered by a strip of good farming land, dotted over with white oaks, and having but little undergrowth. The soil of these valleys is a reddish sandy loam, more or less gravelly, but near the creeks it is more clayey. The soil of the hills in places is adobe in character, but for the most part it is red and gravelly. Immediately north of Redding are found clumps of manzanita and large oak. Very little farming is done in this county, the chief industry being stock raising. The average of cultivated lands is 13.9 acres per square mile. Redding, the county seat, is connected with Sacramento by the Oregon Division of the Central Pacific Railroad.

TEHAMA.

Area, 3,060 square miles. Sacramento Valley, 265 square miles; lower foothills, 2,000 square miles; higher foothills and Sierra mountains, 420 square miles; Coast Range mountains, 375 square miles.

Tehama County is situated at the northern end of the great valley of the Sacramento River, and reaches from the Sierra, on the east, across this valley to the Coast Range of mountains on the west, with an extreme width, east and west, of 86 miles, and a length, north and south, of about 35 miles. The topography is greatly varied, the Sacramento River forming a central feature, with its very level and open valley of from 7 to 15 miles width, bordered on the east, north, and west by a region of foothills, which extend back, with increasing altitudes, to the foot of the mountains. The valley, foothills, and mountains thus constitute three general divisions in their agricultural features.

All the streams heading in the Sierra run in deep cañons, which open upon the Sacramento Valley in gate-like chasms, the lava formation through which they flow terminating here with an abrupt edge. Below this is a barren treeless belt covered with volcanic fragments, which, gradually sloping to the west, merges in the fertile bottom lands along the river.—[*Natural Wealth of California*.

The *Sacramento Valley* is the most important of these divisions, comprising, as it does, the chief grain-producing part of the county. The valley proper has its head a short distance above Red Bluff, on the river, on both sides of which it extends southward in a belt of a few miles width through the county, widening out rapidly to the westward below the county line. Along the immediate banks of the river there is a narrow strip of bottom loam, very rich and productive, whose original growth was cottonwood and sycamore, but the soil of the valley proper is a reddish loam, with no timber, the surface presenting a broad and open prairie plain.

The *foothills* are rolling, treeless, and usually much broken; but they are interspersed with narrow valleys, watered by streams flowing into the Sacramento River. The hills are generally too rocky and barren for the culture of grain, but are thought to be suitable for grapes. The soil is chiefly a red gravelly and rocky loam, or clay. Near the foot of the mountains stock raising is almost the only pursuit.

The *mountains* are too high and barren for agricultural purposes. Those of the Sierra are generally timbered with spruce and pine, and covered with snow for most of the year; those of the Coast Range are lower in altitude, and have a growth of inferior pine and oak. Lumbering is the chief industry in the mountains.

Wheat is the chief crop of the county, though fruits, grapes, etc., are now receiving more attention. The lands of the county under cultivation average 88.3 acres per square mile, the average of population being but 3 persons per square mile.

The agricultural or valley region is supplied with transportation facilities by the California Pacific and Central Pacific Railroads, which pass through, west and east of the river, via Willows and Sacramento, to San Francisco.

YOLO.

(See "Great Valley Region.")

COLUSA.

(See "Great Valley Region.")

PLUMAS.

(See "Sierra Mountain and Higher Foothills Region.")

BUTTE.

(See "Great Valley Region.")

SIERRA.

(See "Sierra Mountain and Higher Foothills Region.")

YUBA.

(See "Great Valley Region.")

NEVADA.

Area, 990 square miles. Lower foothills, 440 square miles; higher foothills and Sierra mountains, 550 square miles.

Nevada, a long and narrow county, extending from the State line westward across the high Sierra, and southwestward into the foothills, is watered chiefly by South and Middle Yuba Rivers, and Elk Creek on the north, while Bear River marks the southern boundary, all flowing west toward the Sacramento River.

Several small lakes occur among the mountains of the east, the largest being Donner Lake, 2 miles from Truckee. The greater part of the county on the east is rugged, wild, and uninhabited (the mountains, in places, rising more than 8,000 feet above the sea), and is almost exclusively devoted to mining operations.

The western part, or less than half the county area, lies within the foothill region, and embraces the lands suitable for farming purposes. Its extreme altitude is not over 2,000 feet. Near the mountains its surface is very broken and hilly, the low spurs of the Sierra reaching far westward and forming a region "diversified with deep ravines, knolls, and dales, rolling prairies, wooded mountains, and gently sloping hills. It has a mixed growth of oak and pines, occurring in clumps, and an undergrowth of buckeye, chamisal, wild lilac, and manzanita." Lumbering is the chief industry among the forests of pine, spruce, fir, sugar pine, and cedar. The extreme western part of the county is less broken, and the lands more in cultivation. The soils of the uplands comprise red loams, more or less generally, or gray sandy granitic lands; those of the bottoms and flats are often dark alluvial loams.

The county averages 2.1 persons per square mile. The cultivated lands average 25.6 acres per square mile for the county at large, or about 5.7 acres for the foothill and valley region.

The Nevada Central Railroad connects with the Central Pacific at Colfax, the latter road also traversing the eastern part of the county.

PLACER.

Area, 1,480 square miles. Sacramento Valley, 220 square miles; lower foothills, 450 square miles; higher foothills and Sierra mountains, 810 square miles.

Placer, one of the narrow counties that extend from the State line westward to the Sacramento Valley, has Bear River for a part of its northern, and the North and Middle Forks of the American River for the greater part of its southern boundary.

A number of other large creeks, either tributary to the latter river or flowing independently toward the Sacramento, aid in supplying an abundance of water for mining or irrigating purposes. The forks of the American River flow through deep cañons and narrow gorges, which are from 1,800 to 2,000 feet below the general level of the country. Lake Tahoe covers a large surface on the high Sierra region on the east.

The county is naturally divided into the following general regions:

1. The *high Sierra mountain region*, on the east, rising from 7,000 to 10,000 feet above the sea, and embracing a wild and rugged country, subject to heavy snow and landslides, well timbered with pine, fir, and cedar, and but little inhabited.

2. An *upper foothill region*, from 2,000 to 4,000 feet, extending westward to near Auburn, and embracing a broken and very hilly country, well timbered, and devoted chiefly to lumbering and mining.

3. A *lower foothill region* of less than 2,000 feet altitude, embracing a region of rolling lands and low hills, somewhat broken in character, and partly timbered with white, live, and black oaks, Sabin's pine, buckeye, manzanita, and chaparral. These hills are devoted chiefly to fruit culture, and the valleys to hay and alfalfa. That part of the region reaching from two miles west of Auburn to the higher hills has chiefly red gravelly lands, while the remainder is granite in character, and its soils are lighter and partly sandy. Both are well adapted to fruits. Granite bowlders and outcrops are abundant. This granite belt extends through the county north and south, with an average width of about ten miles.

4. The *Sacramento plain*, with an elevation of about 40 feet above the sea, and embracing a level or slightly undulating country, with

swales or depressions, and almost treeless, except along the watercourses, where a few oaks vary the monotony.

The line dividing the plains from the foothill region passes from Folsom (Sacramento County) to Rocklin, and thence eastward of Lincoln and Sheridan to Bear River, on the north.

The soil of the valley or plains is a red loam, with a stiff clay subsoil, underlaid by a yellowish hardpan; within the swales or depressions the stiff clay appears as an adobe, the county greatly resembling that of Sacramento. The lands under cultivation average 68.8 acres per square mile for the county at large, or about 152 acres for that part outside of the mountainous portion.

The Central Pacific Railroad, with its Placerville branch, affords the western part of the county abundant transportation facilities, also passing near the northern border of the eastern or mountainous country.

EL DORADO.

Area, 1,800 square miles. Lower foothills, 780 square miles; higher foothills and mountains, 1,020 square miles.

El Dorado County reaches from the State line westward almost to the level plains of the great valley, and is watered by the American and Cosumnes Rivers and their many tributaries. The former rising in the east flows centrally through the county with a channel far below the general level of the country through which it passes. Lake Tahoe extends into the county on the northeast, while several smaller lakes occur within this mountainous region.

The eastern part of the county, reaching westward to within 10 or 12 miles of Placerville, is high, mountainous, and rugged, embracing the high Sierra, which rises to an altitude of 8,000 feet and more. The western slope of this mountain region is heavily timbered, and lumbering is the chief industry.

The rest of the county, embracing a belt about 30 miles wide, is a region of foothills, and contains a scattered growth of white and black oak and pine, except in the extreme west, which is mostly destitute of timber. From its elevation of about 2,000 feet on the east the surface of the foothills falls westward to the plains, hilly and broken at first, but becoming more level, and embraces the only farming lands of the county. Many small valleys occur in the eastern foothills region, but they are said to have suffered very greatly by the washing away of their soils by placer mining. The lands of the county are chiefly red gravelly loams and clays, and, along the streams, strips of alluvial loams. The cultivated lands average for the county at large 18.8 acres per square mile, while the average of population is not quite 6 persons.

The Sacramento and Placerville Railroad runs from Sacramento to Shingle Springs, 10 miles from Placerville.

SACRAMENTO.

(See "Great Valley Region.")

AMADOR.

Area, 540 square miles. Sierra mountains and upper foothills, 90 square miles; lower foothills, 450 square miles.

Amador County is very narrow, and lies east and west between the foot of the high Sierra and the Sacramento plains, being bounded on the north in part by a fork of the Cosumnes River, and on the south by the Mokelumne River. Numerous creeks, flowing independently of these rivers westward towards the Sacramento, aid in supplying the county with an abundance of water.

The eastern portion is very narrow, and for a distance of 25 or 30 miles is embraced within the upper foothills region, having an elevation of from 2,000 to 4,000 feet above the sea. Its surface is rugged and broken (the streams finding their way through deep cañons) and well timbered. The rest of the country, or lower foothills region, is hilly and partly timbered, and interspersed with numerous fertile valleys, varying in length from 3 to 6 miles, and in width from 2 to 3 miles. Ione and Jackson Valleys are each 12 or 15 miles long, and from 2 to 5 miles wide. The soils are red loam, more or less gravelly, with a scattered growth of oaks. The chief crops are wheat, barley, potatoes, and fruits. Irrigation is necessary, and water is brought in ditches from the large streams.

The largest of these, the Amador Canal, is connected with the north fork of the Mokelumne River, and has a length of 60 miles. The lands yield from 20 to 30 bushels of wheat and 25 bushels of barley per acre.

The western part of the county is connected with Sacramento and San Francisco by the Amador branch from Ione City to Galt, and thence by the Central Pacific Railroad.

Lands under cultivation average 68.1 acres per square mile for the county at large, or about 81 acres for the foothills region.

CALAVERAS.

Area, 980 square miles. Lower foothills, 800 square miles; higher foothills, 180 square miles.

Calaveras County is bordered on the north and south respectively by the Mokelumne and Stanislaus Rivers, which, rising not far from each other in the Sierra, rapidly diverge as they flow southwestward and give to the county a triangular shape. These two rivers, with Calaveras River, which rises near the center of the county and flows westward, are the principal streams, and have numerous small tributaries. The surface of the county is hilly and broken throughout, the western boundary resting among the lower foothills near the great valley. The general level rises rapidly to the summit of the high Sierra on the east.

Bear Mountain, a rocky, wooded range, a little more than 2,000 feet high, strikes northerly across the middle of the county from the Stanislaus to the Calaveras River, dividing this central portion into two sections, the lower composed of abrupt foothills, that gradually subside into low rolling prairies as they stretch west toward the great San Joaquin Valley, while the upper grows more rugged and broken as it extends eastward into the main Sierra. * * * The upper and steeper slopes of the foothills are covered with scattered groves of oak, interspersed with an inferior species of pine, buckeye, manzanita, and other shrubby trees. Large patches are covered wholly with the chamisal (*adenostoma*), an evergreen shrub with a delicate leaf, which, seen from afar, gives to the mountains a beautifully dark umbrageous appearance.

One of the greatest curiosities in California consists of the Big Tree Grove, situated on the divide between the middle fork of the Stanislaus and Calaveras Rivers, about 20 miles east of Mokelumne Hill, and at an elevation of 1,759 feet above the level of the sea. The trees range in height from 150 to 327 feet, and in diameter from 15 to 30 feet.—[*Natural Wealth of California.*

Mining is the chief industry of the county, and comparatively little farming is carried on. The lands under cultivation average but 30 acres per square mile for the county at large, being chiefly embraced in the lower foothills region. Fruits comprise the principal crop. The soils are chiefly the "red foothills," similar to those of Tuolumne County. Numerous canals have been dug from the rivers to convey water for hydraulic mining and other purposes, the two largest of these, the Mokelumne Hill and Seco Canal, on the west, connecting with the Mokelumne River, and the Murphy Canal, in the eastern part of the county, taking its water from the Stanislaus River.

Transportation facilities are afforded the western part of the county by the San Joaquin and Nevada Railroad, which extends westward through San Joaquin County, along the south side of the Mokelumne River, to Brack's Landing, where a line of boats connects with San Francisco; also, by the Stockton and Copperopolis Railroad, reaching from the southwest part of the county west to Stockton, and thence by railroad or boat to San Francisco or Sacramento.

TUOLUMNE.

Area, 1,980 square miles. Lower foothills, 520 square miles; higher foothills and Sierra mountains, 1,460 square miles.

Tuolumne, one of the foothill counties, is separated from Calaveras on the northwest by the North Fork of the Stanislaus River, which, with its tributaries, drains that portion of the country. The greater part of the county is, however, watered by the Tuolumne River and many tributaries that, rising in the Sierra, flow westward, its drainage basin being entirely within the county until the western boundary line is reached. The surface of the country is hilly and broken, rising rapidly from the lower foothills, near the San Joaquin plains, eastward to the high Sierra mountains, 14,000 feet above the sea. The greater part of the county, because of its hilly and broken character and its elevation, is untillable. The lower foothills in the west, where not too broken, are being successfully cultivated in grapes and fruits, while the narrow valleys are planted in alfalfa and grasses for hay. This western region, and especially the valley of the Stanislaus River, has been occupied chiefly with mining camps, quartz mining being a large industry. Lumbering is also carried on extensively in the timber region of the Sierra, "which is located about centrally with reference to the eastern and western boundary line of the county and extends the entire breadth, its area being about 50 miles long and 25 wide." The timber comprises pine, fir, and cedar, and a number of sawmills are located upon the western limit of the region. In the mountainous portion of the county, on the east, there are many lakes at the heads of the tributaries of the Tuolumne River. Lake Elnor, the largest of these, is situated in a valley 4 miles long and averages 1½ miles in width. The land bordering it is a sandy loam, producing a luxuriant growth of native grasses. A portion of the valley is well wooded and the gentle slopes and ridges on both sides are covered with a great growth of pines and firs. Numerous canals have been constructed, mainly for nursery purposes, to carry the waters of the rivers to many points in the county. The Big Oak Flat Canal is some 40 miles long and that of the Tuolumne County Water Company (the "Tuolumne Ditch") about 35 miles.

The cultivated lands average 12 acres per square mile for the county at large, the average population being about 4 persons per square mile. The San Joaquin and Nevada Railroad, when completed, will give the county good transportation facilities. At present communication is by way of the Southern Pacific Railroad, in Stanislaus County.

STANISLAUS.

(See "Great Valley Region.")

MERCED.

(See "Great Valley Region.")

MARIPOSA.

Area, 1,560 square miles. Lower foothills, 530 square miles; higher foothills and Sierra mountains, 1,030 square miles.

Mariposa County reaches eastward from the edge of the San Joaquin plains across the foothills far into the Sierra mountains, its altitude thus varying from about 300 to from 10,000 to 13,000 feet, that of Mount Dana being 13,277 feet. The largest stream of the county is the Merced River, which rises on the extreme east and flows westward to the plain. On the south, Chowchilla River forms part of the boundary between this and Fresno County, while numerous smaller streams flow westward into Merced County. The eastern part is timbered with pine, spruce, and cedar, the central with oak and pine, while the western is sparsely timbered, and the extreme west is almost treeless.

The most prominent point of interest in the county is the celebrated Yosemite Valley, situated on the east at an elevation of 4,060 feet above the sea. The valley proper is about 8 miles long, and from one half to one mile wide, the greatest breadth being 3 miles. The Merced River flows through it, while on either side are very high cliffs, rising in places thousands of feet above the valley. On the lower mountain slopes, and in the valley, are groves of pine, with some oak, willow, and cottonwood. This valley is famous for the grandeur of its mountain scenery and waterfalls, and is under State control as a place of resort for tourists. Its further description lies outside of the province of this report.

The mountainous portion of the county, too high and broken for cultivation, extends westward to within a few miles of Mariposa, the county seat. A region of foothills of from 2,000 to 4,000 feet altitude then crosses the county from northwest to southeast, and reaches westward about 15 miles beyond the county seat and into the southern part of the county. It is hilly and broken, interspersed with prominent mountain chains, and is well timbered with pine and oak, the source of supply for the mining camps of the region. Very little farming is done in this part of the county, except on a small scale in the valleys. The extreme western part is more level, its hills being susceptible of cultivation, and is but sparsely timbered with white and blue oaks. The soil of the hills is mostly a reddish clay, that of the valleys or lower lands being chiefly a dark loam with red subsoil. Some farming is done in this lower foothill region, small grain, fruits, and vegetables, being produced. The county is, however, chiefly engaged in mining, and these supplies are produced mostly for home consumption. Lumbering is also carried on in the higher foothills and mountain region.

The average acreage of tilled lands per square mile of the county at large is but 9.6 acres; but, assuming that the lower foothills embrace nearly all of the lands under cultivation, the average for that region is nearly 30 acres. Merced is the nearest railroad point for transportation facilities.

FRESNO.

(See "Great Valley Region.")

TULARE.

(See "Great Valley Region.")

KERN.

(See "Great Valley Region.")

SOUTHERN AND DESERT REGIONS.

(Embracing the counties of Los Angeles, San Bernardino, and San Diego.)

LOS ANGELES.

Area, 4,750 square miles. Coast Range mountains, 2,305 square miles; valley lands, 1,480 square miles; desert, 965 square miles.

Los Angeles, the most populous of the counties of the southern region, borders the ocean on the south, while its northern boundary lies in the Mojave Desert. A range of high mountains, the San Fernando and Sierra Madre, passes through the county, with a course a little south of east, and an extreme width of about 30 miles, separating the Mojave Desert from the southern region of large valleys and hills, which comprise the inhabited and cultivable portion of the county, and which alone is well watered by numerous streams rising among the mountains and flowing into the ocean. Of these the most important are the Los Angeles River, rising on the northwest in the San Fernando mountains and valley; the San Gabriel, rising on the northeast, and uniting with the former a few miles from the ocean; and the Santa Ana River, which, also rising on the northeast, in the San Gabriel Range, and flowing through San Bernardino County, enters this county from a cañon in the Santa Ana Mountains of the southeast.

The Mojave Desert region, on the north, elevated more than 2,000 feet above the sea, is a desolate sandy plain, without permanent streams of water and little vegetation other than, locally, *yucca* (sage-brush), some creosote plant (*larrea*), and occasionally juniper and scanty grass. Water may be obtained in wells, but the region, because of the high and hot winds, which stunt or prevent the growth of vegetables or crops, save in protected spots and with irrigation, is hardly inhabited. There is said to be some good land, well adapted to fruits and small grain, in the foothills around Lake Elizabeth, on the western border of the desert, but the same causes have thus far prevented their utilization or occupation. There is also a large amount of alkali land in the low grounds of this section.

The mountain region that passes through the county is the continuation of the Coast Range, and is made up of high chains, trend-ing in every direction, and, except in some of the passes, too rough and broken for tillage. The eastern and northern slopes are said to have many rich and fertile cañons, which are well timbered with oaks, but are not under cultivation. The Soledad Pass, through which the Southern Pacific Railroad has been built, trends westward to the Santa Clara River, and its lands are mostly sandy and gravelly, and have a vegetation, comprising in places oak, willow, cottonwood, and sycamore, with alfilerilla, clover, bunch grass, and sage. The adjoining mountains are largely covered with chamisal brush. The agricultural region proper of the county, embracing that part lying between the mountains and the coast, is from 15 to 30 miles wide, and is divided into three large valleys: The San Fernando Valley, on the northwest, separated from the coast and Los Angeles plain by the Santa Monica Mountains; the Los Angeles Valley, which reaches from the Santa Monica Mountains southeast along the coast to the San Diego County line; and the San Gabriel Valley and its eastward continuation into San Bernardino County, separated from the Los Angeles Valley and the coast by the Santa Ana range of mountains. The two latter valleys form what is known as the Los Angeles plain, itself divided into an upper and lower, the latter reaching from the coast inland for 10 or 15 miles. The lands embrace dark and rich loams, black adobes, reddish mesa lands, and belts and tracts of alkali land, the latter occurring chiefly in the lower plain.

The lower plain, along the coast, is the corn-growing region of this part of the State, its moist lands needing no irrigation and producing fine crops. Gospel Swamp, southeast from Westminster, comprising a very low tract on either side of the Santa Ana River, reaches 10 or 12 miles from the mouth, and has a width of 6 or 8 miles. The tract is especially noted, its yield being from 80 to 100 bushels per acre. Here, also, "pumpkins forget to stop growing."

The crops of the county embrace corn, wheat, barley, and rye, while oranges, lemons, olives, figs, grapes, and other fruits, are also grown. Irrigation is, however, generally necessary; and to secure all the advantages possible, farmers have organized themselves into colonies in the several regions, and have constructed ditches from the streams to supply the needed water. The ditches from the Los Angeles River have a total length of 72 miles, and bring water chiefly to the region of the City of Los Angeles.

Two ditches are taken from the San Gabriel River at the point where it leaves the mountains. One of these, the Azusa Ditch, is, with its branches, about 30 miles long, but its supply is limited. The Duarte Ditch is 12 miles long, and its supply is also limited.

From the two branches of the lower portion of the San Gabriel, between the Coast Range and the sea, there are at least twenty-three ditches of more or less importance, the largest of which is the Arroyo, which is 9 miles long. The beds of the streams are so shallow that water is diverted from them without difficulty by means of simple and inexpensive dams of brush and sand.

The Santa Ana River supplies water to two important canals, as well as to a number of small ones. The Anaheim Canal is 8 miles long, but much water is lost in the coarse sandy soil, and its banks are protected against erosion by willow trees. The Cajon Canal heads at Bedrock Cañon in the Coast Range, and follows along the face of the broken hills for 8 miles before reaching the plateau overlooking the valley. Its total length is 14 miles, and 25 miles of main distributing ditches have been constructed. The Santa Ana Canal has a total length of 20.5 miles. At 8 miles from its head it divides, one ditch skirting around the rim of the valley, and the other passing across the valley, through Orange, to Santa Ana.

The average of lands under cultivation for the county at large is 41 acres per square mile; but, on the supposition that nearly all the lands are included in the valleys south of the mountains, we find the average to be about 131 acres per square mile.

The county is connected by the Southern Pacific Railroad with San Francisco on the north, and with the Atlantic and Gulf ports on the southeast. Branch railroads also run south to the coast from the City of Los Angeles, and there connect with the Pacific Coast line of steamers for the north and south.

SAN BERNARDINO.

Area, 23,000 square miles. San Bernardino Mountains, 2,950 square miles; valley, 465 square miles; desert, 19,585 square miles.

San Bernardino is the largest county in the State, and reaches from the eastern State line southwestward to within a few miles of the coast, the Colorado River, forming a part of the eastern boundary, separating it from Arizona. It is chiefly a part of the great Mojave Desert; and the habitable portion of the country is very small, and is included in the southwestern corner, on the coast side of the San Bernardino range of mountains.

Mojave Desert is described as a sandy and barren waste, interspersed with volcanic mountain ridges and peaks, salt lakes, and alkali tracts, destitute of all growth, except yucca, small nut pines, and juniper, and having but one or two streams. The Mojave rises in the San Bernardino Mountains on the south, and flows for about 100 miles out on the desert and suddenly disappears.

The San Bernardino Mountains of the southwest are thickly timbered with pine, cedar, hemlock, and maple, and are high and impassable, except through a few passes. These mountains are separated from the Temescal and Santa Ana range on the southwest by a broad valley, which embraces the only agricultural lands of the county, and is a part of the valley region that covers a large part of Los Angeles County. Santa Ana River, the chief stream of this part of the county, rises in the San Bernardino Mountains, and with many small tributaries, flows southwestward across the valley, and across the Santa Ana Mountains to the ocean. It is timbered with cottonwood and willows. Santa Ana Valley is divided by a chain of buttes into two parts, the northern receiving the name of the county. The San Jacinto Mountains inclose the valley on the east, the chief outlet thus being on the west into the Los Angeles plains and to the coast.

This valley has, until the past few years, been occupied chiefly by stock raisers; at present, however, its agricultural value is being rapidly developed by a system of irrigation by waters from the mountains and from artesian wells, of which a number have been bored. A number of colonies have been established, and large areas have been planted and made to produce large crops of grapes and fruits of many varieties, prominent among which are raisin grapes, oranges, and lemons. The Cucamonga colony, not far from San Bernardino, and the Riverside colony, occupying a plateau on the south of the chain of buttes, are well known for their excellent fruits.

The surface of Santa Ana Valley presents a gently undulating or level plain, gradually rising toward the hills from the river, and in many places is studded with trees. The soil is a reddish gray gravelly loam, rather stiff in the center of the valley, becoming more and more sandy, and in part gravelly, as the hills are approached; but that at Riverside is red and clayey in character and of great depth. The lands are free from stones, and are said to produce, when fresh, as much as 35 bushels of wheat or 50 bushels of corn per acre.

The foothills have a red gravelly soil, and, with the mesa or bench lands, are excellent for fruits. The valley, surrounded as it is by high mountains, is thus partially protected from the hot and parching winds of the desert, except in the early part of the season, when north winds prevail. The dryness of the climate adapts the valley region especially to raisin making, and Cucamonga is noted for its sweet wines.

The lands under cultivation in the county average 55 acres per square mile; but for the county at large the average, if distributed, would be only 1.1 acres per square mile. Barley and wheat are the chief field crops, but vineyards and citrus orchards are being rapidly brought into prominence.

The valley is supplied with many canals and ditches, which take water either from the Santa Ana River or directly from the mountains. Cucamonga and other districts are supplied with ditches of less length from mountain streams.

The Southern Pacific Railroad passes through the San Bernardino Valley, thus connecting their agricultural portion of the county with San Francisco on the one hand and with the Atlantic States on the other.

SAN DIEGO.

Area, 14,600 square miles. Coast Range mountains, with many small valleys, 7,950 square miles; desert, 6,650 square miles.

San Diego, the extreme southern county of the State, reaches from the Pacific Ocean eastward to the Colorado River, and ranks as second in size among the counties. More than one half of its large area is, however, but a barren desert, embracing a portion of the Mojave Desert on the northeast and the Colorado Desert or Coahuila Valley, in the middle, the two being separated by the San Bernardino Range of mountains, which trends northwest and southeast. The Mojave Desert lands are interspersed with abrupt mountain chains, and are mostly above sea level, while the surface of the Colorado Desert is quite level, free from these mountains, except on the border, and is in many places from 100 to 250 feet below the level of the sea. Both are covered with sand-hills, alkali lands, dry lakes, and a sparse desert growth of yucca, cactus, sage, and creosote bushes, and are destitute of water. The winds often blow with great violence, and sand-storms are produced by even moderate winds. This region is uninhabited, except by a few railroad station hands, and therefore is not under cultivation; but on the border of the Colorado Desert there is a little land planted in fruits, vegetables, and alfalfa.

The rest of the county west of the desert is mountainous, broken, or hilly, and is divided into two natural divisions, viz.: the San Jacinto and Coast Range mountainous region and that lying between the Coast Range and the coast, embracing hills, mesa lands, and valleys.

The San Jacinto Mountains, which border the desert, have an altitude of about 5,500 feet. Between them and the Coast Range there is a lower region of valleys and hills or table lands, about 3,000 feet above the sea, which is watered by several streams which flow westward into the ocean. The mountains are timbered with oak, cedar, pine, and fir. This valley region is chiefly devoted to stock raising, and the population is very sparse.

The coast region, embracing a belt of country along the coast about 25 or 30 miles in width, is rather rolling or undulating near the coast, but becomes more and more hilly and broken eastward to the mountains. This region contains nearly all of the population and the chief farming lands of the county. Within this and the mountain region there are said to be more than thirty valleys varying in length from 3 to 15 or 20 miles, and embracing from a few hundred to upward of 20,000 acres. They are well watered by numerous rivers and their tributaries, except during a portion of the Summer months. Their land is a dark loam, that of the hills and uplands being a red loam or clay, underlaid generally by adobe. Comparatively little of the land of this section is under cultivation, the average probably not being as much as 10 acres per square mile. The crops comprise, chiefly, wheat and barley, with grapes, oranges, lemons, and other fruits. San Diego River, in its course among these hills, is bordered by a number of valleys of various extent, Mission Valley, near the mouth of the river, being from one half to one mile wide, its surface having a loose sandy soil, destitute of trees, but with a thick growth of bushes. The sidehills are clayey and gravelly, and are about 100 feet high. Cajon Valley, 15 or 20 miles from San Diego, is about 6 miles long and 4 miles wide, and has the appearance of a great basin or box (as its name indicates) hemmed in by high gently sloping hills, and is level and treeless, except along the river, where there is a growth of cottonwood, willow, and sycamore. The soil, of no great depth, is sandy and gravelly, and is largely cultivated in wheat and other crops. The upper or northern part of the valley is very narrow, and is bounded by lofty hills and covered with a dense growth of willows with some sycamore.

The Southern Pacific Railroad passes through the Colorado Desert in the eastern part of the county, while the western part is connected with it, at Colton, by the California Southern Railroad, which extends from San Diego northward.

The Pacific Coast line of steamers also connects San Diego with San Francisco, the Bay of San Diego, with its port, affording anchorage for the largest vessels.

COAST RANGE REGION.

(*South of San Pablo Bay.*)

(Embraces the following counties and parts of counties: San Francisco, San Mateo, Contra Costa, Alameda, Stanislaus,* San Joaquin,* Santa Clara, Santa Cruz, Monterey, San Benito, Fresno,* Merced,* San Luis Obispo, Santa Barbara, Kern,* Tulare,* and Ventura.)

SAN FRANCISCO.

Area, 40 square miles. Coast Range mountains or hills, 40 square miles.

San Francisco County, the smallest in the State, and embracing little else than the city and suburbs, is bounded on the west by the ocean and on the east by the Bay of San Francisco, and is separated from the counties on the north by the Golden Gate. Its position is thus near the end of a peninsula, the surface of which is little else than a region of sandhills on the west and rocky ridges on the east, originally covered with a brush growth and rising high above the waters of the bay. Sandstone and serpentine rock formations underlie the hills and outcrop on some of the highest points, as well as at cliffs and bluffs along the shore lines. The county is not an agricultural one and very little of its land is under cultivation except in vegetable and "truck" farms. The even temperature permits the cultivation of temperate zone vegetables throughout the year, while the average is too low for the ripening of fruits. Heavy fogs, brought in by the trade-winds from the ocean, prevail during the Summer months, and on the seaward slope more or less throughout the year. The city is situated on the hills and flats that border the bay on the eastern side of the county, and has a population of 275,000, comprising representatives from almost every nation on the globe. With its extensive wharfage along the bay, its capacious harbor, extending far inland through other connected bays opening out through the Golden Gate upon the great highway to Asia, and affording safe anchorage for the largest vessels, it may be called the metropolis of the West.

SAN MATEO.

Area, 440 square miles. Some redwood; Coast Range mountains, 390 square miles; valleys, 50 square miles.

San Mateo County, bordered on the east by San Francisco Bay, and on the west by the ocean, is mostly mountainous, the north end of the Santa Cruz Range running the entire length, north and south, and having an altitude in some places of 3,000 feet. On the south this range is very steep and rugged, and is covered with redwood, oak, pine, and other timber. The natural growth of the lower hills is chamisal brush, manzanita, poison-oak, hazel, etc. Along the bay shore, on the east, there is a strip of level country, from 1 to 5 miles wide, embracing, it is thought, about 69,000 acres, of which 40,000 are tillable, but a salt marsh, whose extreme width is about 2 miles, forms the immediate border of the bay, in the southern part of the belt. The soil of the plain around Redwood City, the county seat, is an adobe, covering about 3,000 acres, but elsewhere, until the sandhill region is reached, sandy loams prevail, changing to the northward to more sandy soils.

On the ocean shore there is around Halfmoon Bay another belt of comparatively level farming land, about 1 mile wide and 10 miles in length, rising rapidly into the hills and cañons of the interior; also, to the southward, at Pescadero, where, at the mouth of a creek of the same name, there is a valley containing about 4,500 acres of good lands, surrounded on all sides, except the west, by high mountains. Here is the famous pebble beach, where agates, opals, jaspers, carnelians, etc., are found in great abundance. Elsewhere along the coast the hills reach the water's edge, forming high cliffs and bluffs.

Among the mountains and hills there are many small valleys, which, with the adjoining hills, are chiefly used as pasturage for stock and dairy farms, the principal industry of the county.

The average of lands under cultivation for the county at large, in 1880, was 168.1 acres per square mile, or 26.3 per cent of the area. The chief crops are wheat, barley, and oats. Potatoes have been produced extensively, but are very liable to blight. At Pescadero much flax is grown. In this county, as in Santa Clara, portions of the mountain slope are known as "thermal belts," on account of their exemptions from frosts, as well as from the direct inflow of the sea fog.

The county is connected by railroad with San Francisco.

CONTRA COSTA.

Area, 800 square miles. Great valley, 105 square miles; tule, 25 square miles; Coast Range mountains, 625 square miles; valleys, 70 square miles.

Contra Costa County is bounded on the east by the San Joaquin River, and on the north and northwest by Suisun and San Pablo Bays. The chief streams are San Pablo, Pinole, and San Ramon Creeks, the latter being the largest, and giving its name to one of the principal valleys of the county. These streams flow northward into the bays.

The surface of the county is largely mountainous, having the Coast or Contra Costa Range proper on the west, and the Mount Diablo Range in the center and on the east. Mount Diablo itself with its rounded summit, is the highest point in the county (3,896 feet above the sea), and, isolated as it is from other mountains, is the most prominent object. The slopes and higher portions are mainly treeless, and afford fine pasturage, but a forest growth, consisting of a great variety of oaks, covers the ravines of the lower portion, while in the higher, the nut pine, juniper, and a chaparral consisting largely of scrubby oaks, covers large areas.

The mountain is nearly treeless on the north side. San Ramon Valley, which separates the mountain from the Coast Range, reaches from Suisun Bay southward across the county, under different names, into Alameda County, where it connects with Livermore Valley. Between the bay and the foothills of Mount Diablo, a distance of about 15 miles, the valley has a width of about 6 miles, but afterward becomes very narrow, averaging from 1 to 2 miles.

The soil is chiefly a stiff adobe, and in some cases is exceedingly waxy and black. When fresh, this soil yields about 30 bushels of wheat or 40 bushels of barley per acre. A number of large valleys, such as that of Walnut Creek, flanked by rolling sloping land, are connected with this on either side, and are also rich and productive. The lands around Mount Diablo are partly reddish, and more or less gravelly, and partly gray loams. Mount Diablo Valley, which extends from the foot of the mountain 8 or 10 miles northwestward, with a width varying from half a mile to 3 or 4 miles, is very level, and is drained by small streams. Its soils are gravelly loams, with some adobe, and produce fair crops of grain and fruits.

Small valleys are found among the Coast Range mountains, and are usually occupied by dairy and fruit farms; but on the east of the Mount Diablo Range, sloping gently away from its foot toward the river, and reaching north to the bay, there is a large tract of farming land, having a width of from 3 to 6 miles for a distance of 23 miles, which is chiefly given to grain growing. Still eastward of these, and bordering the bay, are large areas of tule lands, covering, it is estimated, about 75,000 acres. Some of these lands have been protected from overflow by levees, and are under cultivation. The tule region is separated from the San Joaquin River by a narrow tertiary ridge running northward from the southern part of the county, and elevated from 30 to 40 feet above tidewater. This ridge has a sandy soil, and affords fine locations for towns.

Within a few miles around the base of Mount Diablo there is a great variation of rainfall. On the west the clouds are apparently caught by the high peaks, with a resulting heavy precipitation, while on the east and south, there is but little rain; *e. g.*, at Antioch, only from 12 to 14 inches. Some of the valleys running westward into the Coast Range are remarkable for their exemption from frost, so that the orange, pomegranate, etc., ripen to perfection.

The lands under cultivation in the county average about 291 acres per square mile, thus placing Contra Costa eighth in the State in this regard. Transportation facilities are afforded both by rail and boat to San Francisco.

ALAMEDA.

Area, 660 square miles. Coast Range Mountains, 415 square miles; valley, 225 square miles; tule lands, 20 square miles.

The County of Alameda lies immediately east of San Francisco Bay, its shore line reaching south from San Pablo Station to the limit of the bay. Thence the county extends eastward to the summit of the Contra Costa Range, and on the south, still eastward, to the Mount Diablo Range, inclosing within its limits the valleys of Livermore, Suñol, Amador, and others. The two mountain ranges are nearly parallel with each other, and rise to altitudes of 2,000 feet or more. They are now treeless on the western and southern slopes (except in the cañons, where there are clumps of oak, laurel, madrone, alder, etc.), though originally having some redwood growth, while on the northern and eastern slopes, besides an abundance of chaparral, there is a scattered growth of both live and white oak, with maple and madrone.

The largest stream of the county is Alameda Creek, which drains Livermore Valley, and, traversing the Coast Range and entering the bay shore, or "Alameda Plains," flows westward to the bay. Its banks are mostly timbered with sycamore and willows. San Antonio and other creeks are tributary to this from the south. Northward from Alameda Creek are San Lorenzo, San Leandro, and other small streams, which have their source in the mountains that bound the Alameda plain and flow westward into the bay. On some of these creeks there is a natural growth of oak, willow, sycamore, laurel, madrone, and buckeye.

Reaching back from the shore with a gradual rise to the hills is a broad and nearly level region, the plain of Alameda. This plain extends through the county, along the bay, with a width averaging about 5 miles, though becoming quite narrow on the north, and is said to have been originally covered with an oak growth; but now there are only a few scattered groves of this timber in addition to the eucalyptus tree, which has been extensively planted in some localities. Nearly, if not all, of the plain is now improved and largely under cultivation in small grain and orchard fruits, including excellent currants; and in the southern part, especially near Mission San José, vines, as well as other fruits, flourish. The creeks coming from the Coast Range are bordered by tracts of light alluvial soil, cultivated by preference in barley and "garden truck," the latter mainly by Portuguese. The bay shore is bordered by tracts of salt-marsh lands, altogether estimated at 35,000 acres, having the usual salt grasses, and penetrated in every direction by lagoons or salt water creeks, which receive the waters of high tides. At some points the bay shore embraces a narrow strip of sandy soil extending along the beach, while inland of this is a level belt of black adobe, or in places, salt marshes.

Toward the hills the lands become more gravelly and lighter colored, and are mingled with bowlders and rock fragments, and there are occasional tracts of adobe lands at the foot, as well as on the hills. The region is thickly populated, and numerous towns and villages dot its surface. Oakland, with its population of 34,555, and situated opposite San Francisco, is connected with it by regular half hourly trains to the end of a long pier or mole (built by the railroad company), and thence by ferry boats. Berkeley and Alameda also enjoy similar facilities for reaching San Francisco.

The mountain range that borders this plain has mostly rounded summits, but is traversed and cut up by numerous cañons, though well covered with grasses, and suited to pasturage and to wheat growing. The hill soils are usually adobe. The hill sides are partly covered with a chaparral of scrub oaks, poison oaks, groundsel tree (*Baccharis*), bramble, etc., with manzanita on the highest points. From Grizzly and Bald Peaks, near Berkeley, probably the highest points in the north part of the range, fine views may be obtained of the Bay and City of San Francisco, the Golden Gate, the mountains of the Coast Range on either side, and the distant Sierra Mission Peak, near Mission San José, is the highest point in the southern part of the county.

The valleys lying between the two ranges of mountains are accessible from the plains by Stockton Pass, a winding ravine leading from the San José Valley to Suñol Valley, the western third of which shows rather abundant and heavy adobe soil of the hills, the slopes being devoid of trees. Eastward the character of the soil changes, becoming of a lighter hue and containing more loam, sand, and gravel, especially in the bottoms. Oak trees occur in some places. The lands of these hills are partly under cultivation, wheat being the chief crop. Suñol Valley, into which the pass opens, is circular in outline, surrounded by hills, and was originally dotted over with oaks. It contains much good farming land. The Vallecitos Valley, separated from Suñol only by a low ridge, is rather narrow, being surrounded by high hills, and its surface is mostly level, interspersed with some hills, and is largely under cultivation.

Livermore Valley, to the eastward of these, is about 14 miles long and from 5 to 8 miles wide, and is surrounded by rolling foothills and mountains. The northern and eastern part of its surface is a plain, the southern and western a region of rolling hills, and all is dotted over with oak trees. It is watered by numerous streams, tributary to Alameda Creek, and along these there is usually a growth of sycamore. The soil of these and of the other valleys that adjoin it is a gravelly loam, very productive, yielding good crops of grain and fruit, among the latter the vine becoming prominent in the upland or hill portion, the level part being too much swept by coast winds for full success.

Amador Valley, on the southeast, is about 8 miles in diameter, and is nearly surrounded by grassy hills, the spurs of the two mountain ranges. Its soil is a sandy loam, and produces good crops of wheat.

The lands of the county under cultivation embrace 47.4 per cent of the total area, and average about 303.5 acres per square mile, the county ranking third in the State, the Counties of San Joaquin and Sacramento alone having a greater average.

STANISLAUS.

(See "Great Valley Region.")

SAN JOAQUIN.

(See "Great Valley Region.")

SANTA CLARA.

Area, 1,400 square miles. Coast Range mountains, 995 square miles; Santa Clara Valley, 405 square miles.

Santa Clara County, with its eastern boundary line upon the Coast Range of mountains, and its western upon the Santa Cruz Range, includes within its limits, mountains, hills, and valleys, which are watered by many small streams flowing partly to the north and emptying into the Bay of San Francisco, and partly south to the Pajaro River, and thence to the Bay of Monterey. The most important of these streams are Guadalupe and Coyote Creeks, on the north.

The mountains on the west are mostly heavily timbered, while the lower hills are covered with grasses, and well suited to pasturage, especially on the west side, where the fogs from the ocean keep the grass green through a great part of the year. The eastern mountains are treeless, save in the cañons. The prominent feature of the county is the Santa Clara Valley, well known for its productiveness and mild climate. With a width of 20 miles on the north, at the southern extremity of San Francisco Bay, the valley reaches southward to about 11 miles south of San José, where it becomes only about 100 yards wide, then opens out to several miles in width, and passes into San Benito County. Its surface is somewhat undulating, with low, rounded hills on the margins, and is dotted with clumps and groves of oak. Its lands embrace black adobes on the northern or lower portions, and lighter, sandy, or gravelly loams on the higher lands. The chief crops are wheat, barley, corn, potatoes, and vegetables, and in the neighborhood of San José, fruit (especially plums, prunes, and grapes), for which culture the climate and exemption from fogs specially adapt the region.

The lands under cultivation average for the county at large 118.7 acres per square mile, the average population being 25 persons per square mile.

Branches of the Southern Pacific Railroad, on either side of the bay, connect San José with San Francisco and Oakland; in addition, the South Pacific Coast Railroad skirts the western shore of the bay.

SANTA CRUZ.

Area, 420 square miles. Redwood lands, 195 square miles; Coast Range mountains, with some valley lands, 255 square miles.

Santa Cruz is one of the most mountainous counties on the southern coast, the ranges, however, being neither high nor much broken. The eastern boundary line rests upon the summit of the Santa Cruz branch of the Coast Range at an elevation of 2,000 feet or more above the sea, extending south to the Pajaro River, while to the west, and separated by the San Lorenzo Valley, is another mountain range reaching southward to the Bay of Monterey at Santa Cruz. Still westward to the coast the country is hilly and broken, often to the water's edge. In the southern part of the county the Pajaro River forms the boundary line, and is bordered by a valley region extending east and west, and embracing rich dark loam and adobe lands, which are well adapted to wheat and barley. This part of the valley, however, is not wide, as the river flows not far from the hills, thus giving the greater part to Monterey County. Northwestward from this there is another valley region lying east of the Town of Santa Cruz, and at the mouth of the San Lorenzo River. It embraces several terraces or benches, which are from a mile to two miles wide, and extend through the valley, the first 30 feet above the level of high water, the second 34 feet higher, and the third 199 feet higher still, showing a total rise of 263 feet. The Town of Santa Cruz is located upon the lowest of these benches, extending southward by Soquel and Aptos to the Salinas marshes. It has been estimated that the bottom lands of the county embrace 40,000, and the terraced plateaus 50,000 acres.

The county is watered by the San Lorenzo and Pajaro Rivers and numerous small streams that flow from the coast mountains to the sea. The mountains are generally heavily timbered almost to their very base with redwood, pine, and chestnut oak, probably to the extent of one third of the county area, while the lower hills are covered to some extent by hazel bushes. The redwood trees of this county are noted for their great size, many of them attaining a height of from 200 to 300 feet, and a diameter of 15 feet. The lands of the San Lorenzo Valley north of Santa Cruz have a sandy loam soil, derived from a fine-grained calcareous sandstone, the prevailing rock of the hills, although granite occurs northward of the Town of Santa Cruz. The soil is deep in the flats, but easily washes away, and on the hills much rock is exposed. This valley is about 20 miles long, and is most generally used for pasturage, though there are a number of vineyards near Vine Hill, about 10 miles north of Santa Cruz. The valley is very narrow, the river often flowing between high hills, while in other places it opens out into wide plateaus; but the hills on either side are sufficiently low for cultivation, and the Santa Cruz Mountains generally are being rapidly occupied for orchards and vineyards. The Town of Santa Cruz is a popular Summer resort by the seaside. The average of lands under cultivation is 95.7 acres per square mile, and the crops embrace wheat, barley, corn, potatoes, and fruits of several kinds; lumbering is also one of the chief industries. The Town of Santa Cruz is one of the great Summer resorts for the people of this coast.

Transportation facilities are abundantly afforded by the vessels of the Pacific Coast Steamship Company that touch at numerous wharves on the coast; also, by the South Pacific Railroad and the Santa Cruz branch of the Southern Pacific Railroad, which passes through the county to San Francisco.

MONTEREY.

Area, 3,520 square miles. Coast Range mountains, 2,420 square miles; Salinas Valley, 700 square miles; other valleys, 400 square miles.

Monterey County is divided into valley and mountain regions by two branches of the Coast Range, which extend northwestward through almost its entire length. The Gabilan Range separates the county from San Benito, while the Santa Lucia Range of almost unbroken lofty mountains extends along the coast, separated from the former range by a broad valley watered by the Salinas River. This river (the most important of this region) rises in San Luis Obispo County and flows northwestward for nearly 200 miles to the Bay of Monterey. The Pajaro, in the northern part of the county, flows westward, also into the bay, but is not a long stream. The Santa Lucia Mountains are, in places, heavily timbered on their lower slopes, and in the cañons, with Monterey pine, cypress, and redwood. The Gabilan Mountains of the east are low and rounded for 18 miles southward from the Pajaro River, and are timbered, but for the next 30 miles, reaching to San Lorenzo, they are high and rough, again sinking to a range of low and rolling hills at the county limit. The range contains much limestone, and among the hills there are a number of small valleys.

The most important agricultural region of the county, although not the largest, is the Pajaro Valley on the northern border, which has a length of about 10 miles, and a width of 6 to 8 miles, extending into Santa Clara County on the east, and Santa Cruz on the north. Its surface is quite level, and embraces three varieties of soils: dark loam land of the plains, well adapted to wheat and barley; adobe lands, comprising one third of the valley or bottoms of Pajaro River, and lying several feet below the plains; and clayey loams, comprising the rest of the river lands, and known as the sugar beet soils. The valley is bounded on either side by a range of smoothly rounded hills, those on the south reaching to within 1 mile of Pajaro Station, and being too steep for cultivation.

The western part of this southern range consists of sandy and untimbered hillocks, while the eastern is more broken, better timbered, and has an abundant growth of white sage. The small valleys or hollows among these hills are mostly swampy, with either willow and tule, and often hold small lakes or ponds of water. This region of hills is several miles in width, and separates Pajaro Valley from that of Salinas River on the south.

The Salinas Valley, traversed by the river of that name, and the largest in the county, reaches from the Bay of Monterey southeastward between the two mountain chains toward San Luis Obispo County for a distance of 90 miles, where it is very narrow and considerably elevated above the sea. The width varies from the first 50 miles from the coast from 12 to 8 miles, gradually rising inland. The valley presents a terraced and almost treeless plain, the only growth being some live oak on the northeast, and sycamores on the streams. Near the upper end of the valley, within the county, are several small valleys, connected with it or separated by narrow and low hills. Long Valley is about 10 miles long and half a mile wide, and is partly cultivated. Its soil is an adobe, covered partly with bunch grass, and the hills bordering it are low, rounded, and treeless, and contain much limestone. Peach Tree Valley, separated from the last by a range of hills some 300 feet high, and timbered with oak and pine, is 22 miles long and three fourths of a mile wide, and has, except over an extent of 5 or 6 miles at the lower end, a scattering growth of white oaks. Its soil is a dark loam, deep and rich. The Coast Range, on the northeast, rises some 1,600 feet above the valley.

The arable land along the coast for about 15 miles south of Carmel Bay is nowhere more than one fourth of a mile wide. Carmel Valley is parallel to and lies west of Salinas Valley, and its lower foothills afford a very good pasturage. Comparatively little of the county is under cultivation, the average being 48 acres per square mile. These lands, however, are mostly confined to Pajaro Valley, and are planted in small grain, potatoes, etc. Experiments have been made with cotton, but after growing about 12 inches high and blooming, the plant suddenly died. The Town of Monterey, on the bay of the same name, is the most popular Summer resort of the coast. A railroad from Soledad and Monterey northward to San Francisco affords transportation facilities to the greater part of the valley portion of the county.

SAN BENITO.

Area, 990 square miles. Coast Range mountains, 875 square miles; valleys, 115 square miles.

San Benito is a long and narrow county. Its northeast and southwest boundary lines lie respectively on the summit of two branches of the Coast Range (viz.: the Gabilan and the inner Coast Range), whence the surface slopes abruptly to the valley of the San Benito River, which flows northwestward through the middle of the county and unites with the Pajaro River. A few small streams, of little importance, are tributary to the San Benito.

The lands suitable for cultivation comprise but a small portion of the county area, and lie chiefly on the northwest, forming the southern end of Santa Clara Valley to Los Pinos, and are drained by the San Benito and Tres Pinos Rivers. This valley land is said to embrace about 25,000 acres of light sandy loam, 34,300 acres of black sandy loam or adobe, the valley land proper, and 46,000 acres of what is termed second-class land, partly sandy loam and partly adobe, lying on the foothills. In addition there is a large amount of hill pasture land. The lower part of this valley, in a "strip reaching from Pajaro River to within 3 miles of Hollister, is a low, flat, wet, partly tule land, with a black soil, used entirely for pasturage."

The valley is from 10 to 12 miles wide below, but a few miles southeast from Hollister it terminates in a kind of rolling bench-land, extending across the valley, and known as Poverty Hill or Hollister Valley. This Poverty Hill region is treeless, its elevation being adobe in character, and in the depressions a sandy loam covers the adobe. At about 4 feet depth, the earth is charged with alkali. Still southeastward the valley becomes very narrow and elevated, and to its source it is rarely one half a mile wide, and often but a few rods. It is here very much cut up, and is almost wholly occupied by the San Benito River. A few white oaks in the valley and live oaks near the hills, with occasional groups of cottonwood on the river, comprise the only timber. The soil of the valley is yellowish and silty; that of the hillsides are adobe, and scarcely under cultivation. The hills bordering the valley are but thinly covered with a scrub growth of oaks. Bitter Water Valley, on the south, a continuation of Peach Tree Valley, of Monterey County, is said to be 7 miles long and from three fourths to one mile in width. This valley is treeless, and the hills that border it have a scanty growth of oak. Its soil is a yellowish and stiff clay loam, and is tilled with some difficulty, except when moist.

Dry Lake Valley, or basin, about 4 miles long, has a dark, clayey loam soil, partly timbered on both hills and in the valley with oaks, and is thickly settled.

Santa Ana Valley, lying eastward of Hollister, has an area of about 15 square miles. Its soil is a dark, gravelly loam, underlaid by adobe, and partly covered with scrubby white oak. This valley opens out into San Benito Valley, and, with it, is very generally under cultivation in the cereals, hay, potatoes, etc.

The first class or valley lands of the county are said to yield from 30 to 40 bushels of wheat per acre, the higher or second class lands from 20 to 30, while the rolling hill lands produce from 15 to 20 bushels per acre.

The average of tilled lands for the county at large is 91.5 acres per square mile; but, as already stated, the entire acreage is confined almost exclusively to the northern part of San Benito Valley, where the average is much higher. The Southern Pacific Railroad affords transportation facilities to and from San Francisco.

FRESNO.

(See "Great Valley Region.")

MERCED.

(See "Great Valley Region.")

SAN LUIS OBISPO.

Area, 3,460 square miles. Coast Range mountains, 2,370 square miles; valleys, 1,090 square miles.

San Luis Obispo County is bounded on the south by the Santa Maria River, which flows westward, reaching the ocean through the Guadalupe Lagoon, the eastern boundary lying along the summit of the Coast Range, which borders the great San Joaquin Valley on the west. The county is divided diagonally into two valley regions by the San Lucia Range, which enters on the northwest, passes through and unites with the Coast Range in the southeast corner, and has elevations ranging from 3,000 feet to that of low hills.

The eastern valley region presents a series of low, rolling hills, interspersed with valleys, watered by Salinas River and San Juan Creek and other streams, all of which flow northwestward.

During the Summer months the waters of these streams do not flow continuously in their channels, but rise and sink alternately at short distances. Salinas Valley, the chief valley of the region, is about 9 miles wide, and has an elevation of about 1,000 feet above the sea. The surface rises on the southeast into a level plateau some 300 feet above the valley proper, and soon terminates against the mountains.

Paso Robles, noted for its medicinal springs, is situated in a plain, about ten miles square, in the lower part of the valley, surrounded by a live oak grove. North of this locality there is but little timber, either in the valley or on the hills, except southward, where the hills are timbered with considerable oak, and, near the mountains, with pine. Manzanita is also abundant in many localities, and chamisal occurs on the hills north of Paso Robles. The soil along the streams is mostly a dark loam covered with alfilerilla and burr clover; that of the uplands is generally a stiff clayey loam, more or less gravelly, easily tilled, interspersed with some adobe tracts, and is covered with alfilerilla, burr clover, bunch-grass, and wild oats, the latter chiefly on the higher hills. There is some loam land on the Santa Margarita and San José, lying contiguous to the Santa Lucia Mountains, while the lands of the Salinas plains are red in color. The valley of Estrella Creek is rolling and partly timbered with very scattering scrub oaks. Its soil is a dark gravelly loam, with some adobe.

The lands of the higher plateau of the southeast, or Carisa plains, are very level, bounded on either side by high and abrupt mountains, and have mostly adobe lands, covered with grasses and devoted to grazing purposes. The entire eastern valley is chiefly a sheep and cattle range, though cereals are successfully grown near the foot of the Santa Lucia Mountains, and "fruit trees have done well in some cases, and the grape thrives to an extraordinary degree."

The coast valleys on the west of the Santa Lucia Mountains are narrow on the north, but toward the south widen out to many miles, and are rolling and interspersed with many high ridges and hills. The San Luis Obispo plain has an elevation of about 150 feet above the sea. The Osos, Laguna, and Chorro Valleys run parallel with each other as far south as what is known as the Mission lands, around the City of San Luis Obispo.

Thence the Corral de Piedra Valley continues south until it intersects the valley of the Arroyo Grande. Beyond this is the Nipomo (more properly an elevated plain) and that portion of the Santa Maria Valley situated on the right bank of the Santa Maria or Cuyamas River, which forms the southern boundary of the county. This region is watered by numerous streams flowing from the Santa Lucia Mountains to the ocean, which are bordered with a timber growth of willows, cottonwood, sycamore, laurel, and live oaks. The hills are sparsely timbered with sagebrush and chamisal. A chain of highlands or hills line the coast, rising in many places directly from the water's edge. These begin just south of Santa Rosa Creek and extend to within a few miles of Cayucos, where a break occurs. Immediately south of Morro or Estero Bay they again follow the coast line to within a few miles of the southern boundary of the county.

The northern section, lying between Santa Rosa Creek and Cayucos, does not exceed 250 feet in height, but south of Morro they attain in places an altitude of 2,000 feet, protecting the valleys from the too direct and unintermitting influence of the sea wind. The protection thus afforded by this natural barrier enables the farmer to raise fine grades of wheat, the most valuable of all the cereals.

The coast region is the chief farming portion of the county. Its lands are of three grades—dark loams of the bottoms, suitable for vegetables, etc.; dark or reddish sandy loams of the valleys, resting on heavy clays, and lighter and gravelly soils of the hills and rougher portions of the valley. The crops of this region comprise wheat, barley, corn, potatoes, and several varieties of fruits and grapes. In the Summer months the prevailing northwest winds occasionally blow with some violence immediately along the coast and through the valleys, which open fairly to the sea, and drive through them great fog drifts, which rise from the ocean in the evenings and settle down at night close to the earth. But at sunrise the fog rises, and rolling up the mountain sides, disappears. The valleys lying closer to the western slope of the Santa Lucia Range are comparatively exempt from the winds and fogs. The lands of Corral de Piedra Valley have a heavy loam soil, with streaks of adobe, and are said to yield 40 bushels of wheat per acre. The average of lands under cultivation in the county is 51.3 acres per square mile, while the average of population is but 2.6 persons per square mile. Dairying and cheese making is extensively carried on in the county.

A short line of railroad connects San Luis Obispo with Port Harford, where the steamers of the Pacific Coast Steamship Company touch regularly.

SANTA BARBARA.

Area, 2,200 square miles. Coast Range mountains, 1,900 square miles; valleys, 300 square miles.

Santa Barbara County is hilly and mountainous, a large proportion being too high and broken for cultivation. The San Rafael Mountains cover more than one third of the county on the northeast, while on the southeast the Santa Inez rises as a narrow range parallel with the coast to an altitude of 3,000 or 4,000 feet.

The western coast line of the county has a north and south trend to Point Concepcion, where it turns abruptly to the east. Lying parallel with this latter portion, and at a distance of about 30 miles, are a number of islands, also, mountains, rising as high as 1,500 feet above the sea. The county is watered by the Santa Maria River on the north and by the Santa Inez on the south, both flowing westward into the ocean and bordered by important valleys.

Santa Maria Valley is about 30 miles long and 10 wide, and lies partly in San Luis Obispo County. The soil is sandy, dotted over with oaks, and has a vegetation of clover and alfilerilla. This valley is chiefly devoted to grazing purposes. The Santa Inez Valley is about 30 miles long and averages 2 miles in width, the width in both this and Santa Maria Valley being greatest some 15 miles from the coast, which they reach through narrow cañons. The valley soil is chiefly a loam and was originally timbered with oaks. The surface presents a series of terraces of 25, 45, and 95 feet elevation, respectively, above the river, and is timbered partly with oaks and sycamore. The valley is chiefly used for pasturage. The Santa Inez range of mountains lies on the south, separating this valley from the coast valley, in which the county seat is situated. This range is steep and rugged and is covered with chamisal brush, but there are some oaks in sheltered places. The coast valley extending from Gaviota Pass, east of Point Concepcion, to the Ventura County line, and varying in width from 2 to about 6 miles in the central part, has a rise of 300 feet inland, and is divided into an upper and lower valley, the former being known as the Santa Barbara Valley, or plain, from the town of that name, from whose southern edge the valley slopes to the coast, forming the lower valley to the eastward. West of the town, and reaching to the Gaviota Pass, the coast line forms a terrace about 80 feet high, sloping landward and inclosing between it and the mountains the upper valley. The soil of the valley is a sandy loam and is largely under cultivation in grain. Irrigation is necessary in the higher lands only.

Carpenteria Valley, lying east of Santa Barbara, is also a coast valley opening south, and surrounded on the other sides by high mountains, its surface gradually rising to the bald hills. The valley was originally well timbered with live oak and some sycamore and walnut. It is well watered with small streams, in whose alluvial lands strawberries and other fruits are raised. The crops are corn, beans, and potatoes. The foothills and mesa lands bear naturally the wild oat.

On the coast, from Point Concepcion northward to Point Purisima, lies the Lompoc Valley, its length being about 37 miles. This valley is thought to contain about 35,000 acres of arable land, and has been mostly devoted to pasturage.

The Los Alamos Valley, lying along the arroyo of that name, reaches from the mountains to the coast, and between the Lompoc and Santa Maria Valleys, its length being about 40 miles, and its greatest width, 2 miles. The largest portion of this valley lies about 25 miles from the coast, and has a soil varying from an adobe to sandy loam, partly under cultivation. On either side are low rolling hills and connecting valleys.

KERN.

(See "Great Valley Region.")

TULARE.

(See "Great Valley Region.")

VENTURA.

Area, 1,690 square miles. Coast Range mountains, 1,520 square miles; valleys, 170 square miles.

Ventura County is mostly hilly and mountainous, the northern half rising to an elevation of more than 4,000 feet above the sea, and forming a part of the Coast Range. The southern part, while hilly and broken with mountain ridges, is interspersed with numerous valleys, which are well watered and afford fine farming lands.

The Santa Clara and Buenaventura Rivers are the chief streams of the county, both rising among the mountains and flowing to the ocean. The former is the longest, and is bordered throughout its length by a valley, which, from near Newhall, in Los Angeles County, varies in width, from a mile and less, as far as Santa Paula, then widens gradually, until within about 12 miles from the coast it suddenly expands to about 16 miles on the coast. This is the largest valley region of the county, and contains considerable land under cultivation in wheat, barley, corn, and beans. Above Santa Paula, the soil is generally sandy; below, to the coast, it is dark gray silty loam of great depth, and remarkable for its retention of moisture near the surface. Saticoy plain, or delta, of the Santa Clara River, is noted for its high production of corn and beans, a large part of the State's marketable supply being grown here. Hogs are also extensively raised.

Buenaventura River is bordered by a valley about 20 miles long and one fourth of a mile wide, which has sandy soils and is largely under cultivation. The mountain valleys usually have an adobe soil, with much vegetable matter. Those valleys whose elevation is less than 2,000 feet are partly under cultivation in wheat and other grain. Of these the Ojai is most noted, and lies along the Cañada Larga. It has an elevation of from 800 to 1,000 feet, and is divided into an upper and lower valley. This valley is about 6 miles long and 1½ miles wide, and is largely timbered with live and white oaks, and some cottonwood. The soil of upper Ojai is a rich black adobe, yielding 50 or 60 bushels of wheat per acre, while that of the lower valley is a reddish gray sandy loam, much under cultivation.

The Sulphur Mountain Range, between Ojai and Santa Clara Valleys, is remarkable for its extensive deposits of asphaltum, which substance oozes out at certain levels throughout the range, and at times forms bubbling springs and flowing streams of thick petroleum. In the Sespe Valley a flowing petroleum well of high production has been obtained, and numerous others of moderate yield exist in other parts of the county. The soil of the mountains is a reddish loam, largely timbered with fir and pine. Cotton has been successfully raised in this county, but only in very small patches and with extra attention, it being too much exposed to trade winds and fogs from the ocean.

The county is connected with San Francisco by the Pacific Coast line of steamships.

COAST RANGE REGION.

(*North of San Pablo Bay.*)

(This region embraces the following counties and parts of counties: Marin, Sonoma, Napa, Solano,* Yolo,* Lake, Colusa,* Mendocino, Tehama,* Shasta,* Trinity, Humboldt, Siskiyou,* and Del Norte.)

MARIN.

Area, 580 square miles. Nearly all Coast Range mountains.

Marin County is bounded on the west by the ocean, and on the east, in part, by San Francisco and San Pablo Bays; the Golden Gate separating it from the County of San Francisco on the south. A range of mountains passes through it in a northwest direction; Mount Tamalpais, with an altitude of 2,597 feet, being the highest point. The rest of the county embraces high hills and small valleys, watered by numerous streams, flowing chiefly to the bay on the east. Both the east and the west shores are abrupt, and deeply indented by bays, of which Drake's and Tomales are the chief; that of Tomales, on the northwest, being the largest, reaching inland for 16 miles, with a width of 2 or 3 miles, and occupying a valley between two or more mountain ridges. Point Reyes is a narrow, prominent headland. There is but little level land in the county, the valleys along the streams being quite narrow, and the hills approaching close to the shore lines. The mountains were originally timbered with redwood and pine, but the greater part has been cut away; the lower hills and many of the valleys have a sparse growth of oak. The soil of the hills and rolling lands is usually a black adobe, more or less gravelly; that of the valleys, a dark sandy loam, rich and productive.

There is a large area of salt marsh along the eastern shore, some of which has been reclaimed by levees, and is now termed meadow lands. Dairying is the chief occupation of the people of the county, for which the valleys and hills, with their abundant vegetation, afford excellent pasturage. The lands under cultivation average 36.8 acres per square mile for the entire county.

Under the lee of Mount Tamalpais, near San Rafael, the climate of San Francisco Bay is sufficiently tempered to allow the grape and the fig to ripen regularly.

Transportation facilities are furnished by two lines of railroad, which connect by steamer with San Francisco. San Rafael being practically a residence suburb of the former city, is much frequented on account of its milder climate.

SONOMA.

Area, 1,520 square miles. Coast Range mountains, 1,170 square miles (redwood lands, 300 square miles); valleys, 350 square miles; tule lands, some.

The surface of Sonoma County is hilly and mountainous, interspersed with numerous fertile and well watered valleys. The principal stream is Russian River, which, entering the county from the north, flows southeastward for a distance of about 25 miles, and then turns westward to the coast. It has many small tributaries, which drain the greater part of the county, each bordered by narrow valleys. The northern part of this county is the most mountainous, some of the spurs of the Coast Range being from 2,500 to 3,000 feet high. Many of the mountains and some of the lower hills are covered with a growth of redwood, pine, and fir, but, in some of the valleys, and on the northeastern slopes of the hills, there is a scattered growth of oak, madrona, large manzanita, buckeye, etc., with some willow and sycamore along the streams. The southern part, "from the coast inland to Santa Rosa Valley, is a succession of low, well watered valleys, bare of trees, and covered by a good depth of soil and a rich sward of natural grasses, which are kept green for most of the year by the sea mists which roll over them, during the dry Summer months." The low mountain ridges eastward to Napa County are partly covered with a chaparral of chamisal, manzanita, and other growths.

The principal valleys are Russian River and Santa Rosa Valleys on the north and central portions of the county, and Petaluma and Sonoma Valleys on the south, the latter being separated by low mountains. The first two, with Petaluma Valley, form a central valley through the county from north to south, through which the San Francisco and North Pacific Railroad runs to Cloverdale, a distance of 50 miles. Russian River Valley is narrow, and for 15 miles from its mouth was originally covered with a heavy growth of redwood, but otherwise, with the exception of scattered groves of oak, it is almost destitute of trees. Its lands are alluvial loams, very rich and productive. The Valley of Santa Rosa is about 10 miles long and 6 wide, bordered by low mountains on the west and a higher range on the east, and is generally under cultivation. The county seat, located here, is surrounded with oak and other trees. Bennett Valley, 8 miles long and 3 miles wide, unites with this valley near the town, and its soil varies from a red loam to dark adobe, and is largely under cultivation in grapes. The timber growth of the valley and the adjoining hills is white, black, and live oaks, madrona, etc. Petaluma Valley, on the south, is about 20 miles long and 3 miles wide, and its soils are rich and moist and well adapted to the cultivation of fruit, corn, and wheat. There is much salt marsh bordering the bay on the south, the tract being estimated to contain about 17,000 acres; but it is partly reclaimed and under cultivation, two or three years being required before it is made ready for planting.

Sonoma Valley, to the eastward of Petaluma, and separated by a mountain range, reaches about 16 miles northward from San Pablo Bay, and has a width of about 2 miles. At its northern end it forks, passing into Guillocos Valley on the east, while northward it connects with Santa Rosa Valley through Bennett's Valley. Its southern portion is occupied by marsh and tule lands to within a few miles of the Town of Sonoma, the rest of the valley having a light gravelly loam soil, with water not far below the surface. It is almost exclusively devoted to the cultivation of the grape and fruits, transportation facilities being afforded by the Sonoma Valley Narrow Gauge Railroad. There are valleys, of greater or less extent, among the hills in the western part of the county; two of considerable size extending through this region—one the valley of the Estero Americano, running from west to east through Bodego Township, terminating at Tomales Bay; the other Green Valley, extending from north to south, the stream from which the valley takes its name emptying into Russian River. Green Valley is almost exclusively devoted to fruit culture.

The land of the county is classified by the Assessor into four grades. The first and least valuable grade is the mountain, brushy, and bare hill lands, estimated at 300,000 acres, and utilized only for pasturage. The second grade, timber lands and hillside pasturage, is estimated at 200,000 acres. The third grade is mainly rolling lands, denuded of timber, lying along or near the seacoast, used for dairy purposes, and estimated at 200,000 acres. The fourth grade, rich bottom lands, estimated at about 150,000 acres.

Along the mountain and hillsides, some 300 or 400 feet above the valley, there is a "thermal belt" elevated above the frost limits, where many tender fruits may be successfully grown.

The North Pacific Coast Narrow Gauge Railroad runs through the region to the Russian River, affording convenient transportation. There are, also, good shipping points by sea from Tomales and Bodega Bays. The Sonoma Valley is connected with San Francisco by rail and steamers.

NAPA.

Area, 840 square miles. Coast Range mountains, 620 square miles; Napa Valley, 145 square miles; other valleys, 40 square miles; tule lands, 35 square miles.

Napa County, lying in the eastern part of the Coast Range, is a region of mountains, hills, and valleys, one half of its surface, however, being suitable for cultivation. The mountains on the north, culminating in the volcanic peak of Saint Helena, have their highest elevation within the county, and are heavily timbered with fir, pine, and cedar. To the southward they diminish in height, occasionally flattening out into timbered plateaus 1,500 or 2,000 feet above the sea, and well adapted to cultivation; but in the southern part of the county they sink into low, grassy, and broken hills. The eastern, western, and northern boundary lines rest on the summit of the mountains, while the southern is formed in part by the shore of San Pablo Bay. The principal topographical feature of the county is Napa Valley, which occupies, centrally, a northern and southern position, reaching from the bay 35 miles inland, and having an average width of 4 or 5 miles, except in the northern part (above Yountville), which is only about 1 mile wide. The general surface has a gentle slope southward to the tule lands, and is watered by Napa Creek, which, though small, is a tide-water stream, navigable to Napa City for small craft, and is the largest in the county. Along the lower portion of Napa Slough there is quite an extensive belt of tule lands, some of which have been successfully reclaimed, proving very productive. The soil of the upper valley is gravelly loam, while that part of the southern or lower is a sandy loam, rich and productive, and largely under cultivation.

Knight's Valley, on the north, forms a connecting link between Napa Valley and that of Russian River, in Sonoma County, and is about 7 miles long and 2 miles wide, surrounded by high and heavily timbered mountains. The rest of the county consists of a series of mountain ridges and narrow valleys watered by small streams, those on the northeast being included in the basin of Putah Creek. "East of Napa Valley is Conn Valley, half a mile wide by 6 miles long. South of this is Wooden Valley, 3 miles long and 1 mile wide. North and east of Chiles is Pope Valley, 8 miles long by 1 mile wide. South of Pope is Capelle Valley, 2 miles long and half a mile wide. East of Pope is Berryessa Valley, 7 miles long and 1½ miles wide, and bordered on the east by the high range of mountains that forms the boundary line of the county."—[California As It Is.

The Berryessa Valley is an agricultural region and is largely under cultivation. It is surrounded at first by low hills, and further back by high mountains timbered with pine, fir, and some cedar. The lower ranges are covered with thickets of hazel, buckeye, California bay, and lilac, oak, and ash, and an undergrowth of grasses, wild clover, etc. The valley is dotted with oaks and is devoted to wheat, which yields about 30 bushels per acre. The lower hills are planted in vineyards. Conn Valley is also planted in vines and wheat, but at the head there is a plateau of rolling country heavily timbered with pine and black-oak.

The Assessor of the county has estimated that there are 69,051 acres of the best valley land, 38,287 acres of best hill land and poorest valley land, suitable for grazing, 45,891 acres of hill land adjoining the grazing lands, and 31,711 acres of the poorest quality of hill lands.

Cotton has been grown in Napa County at an elevation of 1,500 feet above sea level.

Grape culture is one of the chief industries of the county. The vineyards begin a short distance below Napa City, and extend either side up into the foothills. As we go northward they increase, until in Saint Helena Valley, separated from Lower Napa Valley proper by a narrow pass near Yountville, we find one of the great wine-making centers of the State, and the point where the grape production per acre has been as high as 13 tons, the entire valley and a portion of the slopes, as well as the adjoining plateaus, being occupied by vineyards, wine cellars, etc. Transportation facilities are afforded by the Napa branch of the California Pacific Railroad, which connects at Vallejo with steamers for San Francisco.

SOLANO.

(See "Great Valley Region.")

YOLO.

(See "Great Valley Region.")

LAKE.

Area, 1,100 square miles. Coast Range mountains, 1,000 square miles; valleys, 100 square miles.

Lake County is included between the summits of two branches of the Coast Range, which unite at Mount Saint John's on the north, and have an altitude of from 3,000 to 4,000 feet. The valley thus formed has a length of about 40 miles and a width of nearly 15 miles, the sides of which are bordered "by narrow ridges of broken mountains, separated by deep gorges and narrow cañons, covered with timber, underbrush, wild oats, and wild grapes." Clear Lake is a central feature of the county, covering an area of nearly one third of the valley, and has an altitude of over 1,000 feet above the sea. Its length is about 25 miles, while its width varies from 10 miles on the north to 2 miles on the south, being divided into what are known as upper and lower lakes by Uncle Sam Mountain, which reaches into it and rises abruptly from the water's edge to an elevation of about 2,500 feet. The lake receives the greater portion of the drainage of the county; and has for its outlet Cache Creek, which flows from the southern point eastward through Yolo County. There are no large streams in the county. On the extreme north, and separated from the valley by a range of high mountains, are the headwaters of Elk River, which flows northwestward through Mendocino County.

The mountains are largely timbered with pine, the sugar pine occurring in extensive forests on the north; the hills have an abundant growth of oak and fir. A feature of the southern mountains are the extensive tracts of the chamisal brush, which has been found valuable for sheep.

The farming portion of the county is embraced within the central valley region, lying on the west of Clear Lake and among the hills along the streams.

The eastern shore of the lake is mountainous, but on the west and north of Uncle Sam Mountain there is much level or undulating alluvial loam land from 2 to 5 miles in width, reaching northward above the head of the lake and westward for 15 miles from Lakeport. It is dotted over with oak and willow.

Other valleys are also partially timbered with white oak, and have red sandy and gravelly soils. Coyote Valley is 10 miles long and 3 miles wide, and Long Valley 6 miles long and 2 miles wide. Scott's Valley has sandy soil, and is said to yield 8 tons of potatoes, 30 bushels of wheat, or 50 bushels of corn per acre.

The crops of the county embrace chiefly wheat and barley, but from the luxuriance of the growth of the native grapevine it is presumed that this county will hereafter become an important grape-growing district.

Cloverdale, in Sonoma County, on the San Francisco and North Pacific Railroad, is the shipping point for the north and middle portions of the county, and Calistoga, in Napa County, on the California Pacific Railroad, receives freight for and from the southern part.

COLUSA.

(See "Great Valley Region.")

MENDOCINO.

Area, 3,780 square miles. Coast Range mountains, 3,655 square miles (redwood lands, 745 square miles); valleys, about 125 square miles.

Mendocino is a mountainous coast county, its prominent topographical feature being two chains of Coast Range mountains running nearly parallel and separated by the valleys of Eel and Russian Rivers. The headwaters of these streams rise near the center of the county, on opposite sides of a ridge lying east and west, Eel River flowing thence northward, through Humboldt County, to the coast, receiving the waters of many tributaries along its course, while the Russian River flows southward, through Sonoma County, and drains a smaller basin. Many small streams flow from the western Coast Range of mountains directly and independently into the sea, affording facilities for floating logs, etc., from the mountains and adjoining valleys to the coast.

The Coast Range is covered from one end of the county to the other by a dense growth of redwood, pine, fir, oak, and madrona, with some dogwood, maple, and bay. The tops of the highest peaks, which rise to an elevation of some 6,000 feet, are bare of timber and rugged, and covered only with chaparral. This region is almost exclusively devoted to lumbering. The eastern range of mountains is mostly treeless, and is known as the Bald Hills. There is, however, an abundant growth of clover, wild oats, etc., and the region is largely used as a sheep pasture.

The lands of the county suitable for cultivation have been estimated to cover about 900,000 acres, and lie chiefly in the valleys adjoining the two rivers and their larger tributaries. Two hundred thousand acres more are good grazing lands, while the rest of the county area is rugged and mountainous.

Sherwood Valley, at an elevation of 2,500 feet, is 5 miles long and 1 mile wide. The soil of this valley is mostly a dark sandy loam, and is well adapted to the growth of cereals and fruits.

Shipments of supplies to and from the southern part of the county are made by wagon to Cloverdale, in Sonoma County, and thence by railroad to San Francisco. Coasting vessels carry on an extensive trade between the coast towns and the City of San Francisco.

TEHAMA.

(See "Lower Foothills Region.")

SHASTA.

(See "Lower Foothills Region.")

TRINITY.

Area, 2,490 square miles. Coast Range mountains, nearly all.

Trinity, lying east of Mendocino County, is a long and narrow county, whose northern boundary lines rest upon the summits of two of the chains of the Coast Range, and whose surface is made mountainous and broken by many other spurs and lofty ridges of the same range. It is watered by numerous streams, all having their sources in the county, and flowing eventually into the ocean on the west. Trinity River, the largest of these, rises in the northeast, in the acute angle formed by the two mountain boundaries, flows southwest for many miles, and then turns sharply to the northwest, receiving, in its course, the waters of many tributaries. The southern part of the county has but very few streams, and is little else than a mass of high rugged mountains, with some good grazing lands. Some points are said to rise to an elevation of 11,000 feet and are often covered with snow through the Summer months. They are granitic in character and their sides are cut up into chasms and cañons. The mountain timber growth is for the most part pine, spruce, fir, and oak, with maple in the lowlands. The valleys along the streams are very narrow and afford comparatively little land suitable for cultivation. The entire arable land in the county is estimated to be not more than 15,000 acres, and is mostly confined to the Trinity River and its tributaries, occurring in small tracts and being partly under cultivation.

The valleys and foothills that often border them are sparsely timbered with oak and pine, while on the streams there is some sycamore, cottonwood, maple, laurel, and ash.

Gold mining is the chief and almost exclusive industry of the county. The crops comprise hay and wheat, for which there is a home market. Supplies are mostly brought by wagon across the mountains from Redding, in the Sacramento Valley, on the east.

HUMBOLDT.

Area, 3,750 square miles. Coast Range mountains, nearly all (redwood lands, 1,000 square miles).

Humboldt, a coast county, is very hilly, mountainous, and rugged, and is watered by the Trinity, Mad, Eel, Mattole, and other smaller rivers, all flowing northwestward into the ocean. These rivers are bordered by some narrow valleys, but are not navigable for small sailing vessels for more than a few miles from the sea. From Eureka eastward to the mountains proper, a distance of about 25 miles, the country is hilly and broken. Much of the county is occupied by the outlying spurs and more westerly ranges of the coast mountains, which, near the coast, are covered with heavy forests of redwood, spruce, and pine. The timber belt, varying in width from 8 to 10 miles, reaches from the coast in some places in this county a distance of several miles, leaving at these points an elevated terrace or sandy beach destitute of timber. The most westerly branch of the Coast Range is rugged and broken within the limits of the county, Mount Pierce, one of its highest peaks, being 6,000 feet high. The more easterly ridge, forming the boundary between this and Trinity County, also rises in some places to a considerable height, Mount Bailey, one of its peaks, being 6,357 feet high. There is much chestnut oak (valuable for tanbark) in this region.

Among the mountains there are small valleys watered by the various streams, but the largest tract of level land lies around Humboldt Bay. The timber growth on the streams is willow, alder, cottonwood, maple, ash, and bay, and the soil is chiefly an alluvial loam, deep, dark, and rich. That of Eel River is so black that with its growth of tussock grass it has received the name of "nigger head" soil. Around the bay and near tide-water there is much overflowed or swamp land, separated from the coast line by a low sandhill region covered with a stunted growth of trees. The hills have usually a dark sandy loam soil, and on the east are covered with grasses, clover, and wild oats, affording an excellent grazing country. The hills around Ferndale are covered with the eagle fern, which often grows to a height of 12 feet; and the Valley of Mattole, in which the town is situated, is 12 miles long and from 4 to 8 miles wide, and also contains much of this growth.

The lands under cultivation lie chiefly in the river valleys on the western side of the county, the soils of which are dark sandy loams, easily tilled, and produce good crops of oats, barley, potatoes, and peas. Lumbering is the chief industry of this western section. The eastern part of the county is chiefly devoted to stock grazing. It has been estimated that of the county area there are 921,600 acres of timbered lands, of which 200,000 acres are of madrona, black and white oaks, and laurel, 450,000 acres are adapted to agricultural purposes, and 500,000 acres suitable only for grazing lands.

The county is at present dependent upon coast steamers and vessels for transportation facilities. Humboldt Bay, 12 miles long and from 2 to 5 miles wide, is one of the largest harbors on the coast, and is almost landlocked.

SISKIYOU.

(See "Sierra Mountain and Higher Foothills Region.")

DEL NORTE.

Area, 1,540 square miles. Coast Range mountains, nearly all (redwood lands, 150 square miles).

Del Norte, the extreme northwesterly county of the State, has a mountainous and broken surface, watered on the east by Klamath River, which crosses it in a southwesterly course, and on the west by Snake River and other streams, which flow to the sea. The Siskiyou chain of mountains, having a general though irregular northeast and southwest trend, forms the divide between the two watersheds, and from this other mountains extend almost at right angles, thus giving to the eastern portion of the county a rugged character. The coast is bordered by a range of hills some 600 feet in altitude, while still inland another range rises to a height of 3,000 feet. Most of the county is well timbered with redwood, fir, spruce, pine, some cedar, hemlock, and myrtle, and there is also a considerable amount of open prairie land. The streams usually have small and narrow valleys, together with swamp and overflowed lands, whose area is estimated at 3,500 acres. The chief industries of the county are dairying, lumbering, and to some extent, mining. Comparatively little land is under cultivation, the average being but 6.9 acres per square mile. Steamers and sailing vessels run between Crescent City, the county seat, and San Francisco.

HIGHER FOOTHILLS (OVER 2,000 FEET) AND SIERRA MOUNTAIN REGION.

(Embraces the following counties and parts of counties: Siskiyou, Modoc, Lassen, Shasta,* Tehama,* Plumas, Sierra, Nevada,* Placer,* El Dorado,* Amador,* Alpine, Calaveras,* Tuolumne,* Mariposa,* Mono, Inyo, Fresno,* Tulare,* and Kern.*)

SISKIYOU.

Area, 5,660 square miles. Sierra mountains, 2,550 square miles; Coast Range mountains, 2,210 square miles; valleys, 900 square miles.

Siskiyou, one of the most northern counties of the State, embraces a region of mountains and high valleys and broad plateaus. The Sierra Nevada and Coast Ranges meet in this county, the culminating point being Mount Shasta, near the southern limit. This celebrated mountain has an elevation of 14,440 feet above the sea, its upper 4,000 feet being covered with snow throughout the year, while its lower 7,000 or 8,000 feet has heavy forests of sugar and pitch pine on all sides but the north, which has only a stunted growth of cedar and oak.

The Coast Range is most picturesque in this county, the summits being very unlike the rounded hills surrounding the bay of San Francisco, for they rise with their rocky formations of granite and slate into rugged and precipitous peaks. The Sierras also consist in great part of rough and rugged buttes, much of the country thus comprising cañons, gorges, ravines, abrupt mountain walls, precipices, and endless little valleys. This wild country is covered with forests of redwood, fir, and sugar pine.—[*California as It Is.*

The eastern part of the county is a high plateau of lava beds, from 3,000 to 4,000 feet above the sea, interspersed with mountains and volcanic peaks rising many thousand feet higher. A large part of the county is without drainage; but the Klamath River crosses the northwestern corner from Oregon, receiving from the south the waters from Scott's and the upper part of Shasta Valley. In the southern part of Shasta Valley the Sacramento River has its source, flowing southward, while on the east of the mountain McCloud River rises, flows southeast into Shasta County, and finally empties into the Sacramento.

The chief agricultural lands of the county are embraced within Shasta and Scott's Valleys on the west, though there are a few smaller ones that have some good farming land.

Scott's Valley is 40 miles long and 7 miles wide, and lies between Trinity and Salmon Mountains of the Coast Range, which rise to an elevation of nearly 6,000 feet, the valley itself being about 3,000 feet. It is largely under cultivation, yielding grain, fruits, and vegetables. Owing to its elevation, the harvests are late, the grain not being reaped until August or September. Frosts are frequent during the Spring and even the Summer months. The weather in the Summer is warm, with cool nights; in the Winter, often severe, especially on the mountains, where the snow falls to a great depth. Snow also lies to the depth of a foot or two, often for several weeks, in most of the valleys, rendering the use of snowshoes and sleighs a general necessity. Shasta Valley is a barren lava plain, containing, however, a few fertile spots. The whole county is particularly adapted to stock raising, hay for Winter being raised upon the meadows along the watercourses, while the hillsides are covered with bunch grass and other nutritious food. Lumbering and mining are the chief industries of the county.

The average of lands under cultivation is 9 acres per square mile. Supplies are hauled to and from Redding, in Shasta County, the nearest railroad station.

MODOC.

Area, 4,260 square miles. Sierra mountain lands, 3,685 square miles; Surprise Valley, 400 square miles; other valleys, 175 square miles.

Modoc County, in the extreme northeastern corner of the State, has a mountainous and broken surface, drained chiefly by Pit River, which flows southwestward through the county from Goose Lake, on the northern border. The tributaries of this river are chiefly on the south and east, the northwestern part of the county having no drainage system.

The only lands suitable for cultivation are embraced in a few of the valleys in the eastern and southern parts of the county, and of these Surprise Valley is the most important. This valley, lying on the extreme east, extends from north to south, and includes in its eastern side three large lakes, whose lengths are respectively 16, 20, and 15 miles, with width of from 3 to 5 miles. These lakes have no outlet, and sometimes are dry by evaporation. The length of the valley is about 60 miles, and width 15 miles; and it is skirted on two sides by lofty and timbered mountains. It is watered by numerous streams, and is covered with clover and grasses. Its soil is a rich black loam, occupying a strip from 2 to 6 miles in width, whose surface gently slopes toward the lakes. The valley is settled up in neighborhoods, and is partly under cultivation, wheat, barley, and vegetables being the chief crops. Dairying, stock raising, and lumbering are also carried on to a considerable extent.

The valley of Goose Lake lies mostly on the eastern side of the lake (which is 30 miles long, and 15 miles wide, extending into Oregon), reaching back some 4 or 5 miles, and is watered by numerous small streams. Its lands are good for farming purposes, being covered with bunch and other grasses, and are partly under cultivation, yielding crops of wheat, barley, oats, etc. The adjoining mountains, Warner's Range, are heavily timbered with cedar and pine, while on the hillsides and around the lake is an abundant growth of wild plums. On the western side of the lake there is a narrow strip of valley, devoted mostly to dairying. Big or Round Valley, on Pit River, in the southwestern part of the county, and reaching into Lassen County, is 30 miles long and 18 miles wide, and is mostly covered with sagebrush. Its soils are varied in character, from red clays to dark loam and gravelly lands, and spotted with alkali tracts.

Surrounding the valley are several creeks, whose rich bottom lands are, to some extent, under cultivation. Stock raising is the chief industry. The lands under cultivation average but 4.7 acres per square mile for the county at large.

LASSEN.

Area, 5,000 square miles. Sierra mountains, 4,425 square miles; valleys, 575 square miles.

Lassen County embraces a region of rugged mountains, arid and sandy sage plains, vast areas of alkali flats, and clusters of broken hills, with narrow valleys, and lies on the north and east of the Sierra Nevada Mountains, which trend northwest. The Diamond Mountain range, 8,200 feet high, and covered with spruce, pine, and fir, separate it from Plumas County on the south. The other mountains of the county trend in various directions, and have only a few scattered groves of scrubby pitch pine, or "piñon," and dwarf cedar. The only streams of importance are Susan River, in the south, and Pit River, which crosses the northwestern part of the county, the former, with several tributaries, flowing eastward into Honey Lake, while the latter is one of the principal tributaries of the Sacramento.

The rest of the county is almost entirely without streams and includes what is termed the Madaline plains, 5,300 feet above the sea, which is covered with sagebrush. There are several lakes in the southern part of the county covering areas from 12 to 15 miles long and from 8 to 10 miles wide.

Comparatively little of the county surface is suitable for cultivation, the chief bodies of arable land being found in Honey Lake Valley, and in Long Valley, farther south.

The lands of the eastern side of Honey Lake are dry and barren, but on the western side there is a strip of rich sandy loam soil about 2 miles in width and largely under cultivation, yielding from 25 to 30 bushels of wheat per acre with irrigation, which is found to be very necessary. The elevation of the valley is about 4,200 feet. The land on the streams is a dark loam, and is mostly covered with plums, poplars, and willows.

Long Valley reaches southeastward to within 15 miles of Reno, in the State of Nevada, and is quite narrow, except near Honey Lake, "its south side being formed by a very high, heavily timbered ridge, while the rise in the north is gradual and the country dry, timberless, and open. The valley is about 40 miles in length, but is very narrow, having an average breadth of only two or three miles. The principal business of its settlers is the raising of stock and dairying. * * * In the extreme northwestern part of the county, and extending into Modoc County, lies Big Valley, a large stretch of agricultural lands, comprising in this county about 75,000 acres. * * * The mountains that border the valley on the south and west are timbered with oak, cedar, and pine, while the country on the east consists of long oval hills and table lands, stretching away to what is known as Madaline plains. These hills and table lands are interspersed with small valleys, which are adapted to grazing purposes. The small valleys are preferred by settlers as locations because of the proximity of timber, and also of the adjacent hills, which constitute a range for stock. * * * Between Big and Honey Lake Valleys lie Grasshopper, Willow Creek, Eagle Lake, and Horse Lake Valleys, separated from each other and the main valleys by intervening ridges of various heights. Each of the last named valleys are very small and contain but few ranches, and are mostly occupied by the bodies of water from which they derive their name."—[California As It Is.

The crops comprise wheat, barley, oats, rye, corn, etc., for which there is a home market. Supplies for the Pit River region are hauled from Red Bluff, in the Sacramento Valley; those for the Honey Lake region are hauled from Reno, a railroad station in the State of Nevada.

SHASTA.

(See "Lower Foothills Region.")

TEHAMA.

(See "Lower Foothills Region."

PLUMAS.

Area, 2,760 square miles. Lower foothills, 100 square miles; higher foothills and Sierra mountains, 2,660 square miles.

Plumas County is mountainous and very broken, the greater part having an elevation of 3,000 or 4,000 feet above the sea. It is watered by the headwaters of Feather River, which, spreading out toward the northeast and northwest, unite on the southwest and flow toward the Sacramento River. Both these streams have cut their way through gorges and cañons from 300 to 500 feet below the general level of the country, that of Feather River being deepest in the State.

While the central and southwestern part of the county is thus divided into cañons separated by high ridges, the eastern and northern portions rise into the high Sierras, over 6,000 feet above the sea. The surface of the country is well timbered with sugar and yellow pines, spruce, fir, and cedar, the forests being denser upon the slopes of the Sierras than in the lower country on the west and south. Many valleys occur among the high hills of the upper foothill region at the base of the Sierra, and are to some extent suited to farming, but especially to grazing purposes, and most of them are covered with grass. The soil is chiefly coarse sand and gravelly, producing but little dust in dry seasons.

A series of grassy and well watered but treeless valleys stretch across the county for 100 miles in a southeastern direction, connected with each other by cañons, passes, or low divides. The first, in the northwestern, is Big Meadows, comprising some 3,000 acres of fertile land, mostly covered with grasses, and capable of producing crops of grain without irrigation. This, with Mountain Meadows, 15 miles northeastward, and of small area, is mostly devoted to stock raising. Butte Valley, 5 miles south of Big Meadows, is 3 miles long and 1 mile wide. Greenville is in a small valley southeastward of this. Passing southeastward, across a well wooded divide of 4 miles, we come into Indian Valley, which has a length of 8 miles and a width of 4 miles, the whole consisting of first-class farming and grazing land, the chief crops of which is oats. Eleven miles southeastward is Genesee Valley, distinguished for the large amount of vegetables produced by the few settlers. Clover Valley, on the North Fork of Feather River, is a long, gorge-like depression, narrow at its lower end, but spreading out as we ascend, till it reaches a width of a mile or more. Dairying is the chief pursuit in this valley. A few miles southeastward, over another low wooded divide, brings us to the lower end of Sierra Valley, a depression some 20 miles long and 10 miles broad, neither so fertile nor so well watered as the others.—[*Pacific Rural Press.*

Oroville, in Butte County, and Reno, in the State of Nevada, are the nearest railroad points from the western and eastern parts of the county, and thence supplies are hauled in wagons.

SIERRA.

Area, 820 square miles. Lower foothills, 200 square miles; higher foothills and Sierra mountains, 680 square miles.

Sierra County embraces a region of high mountains and table lands, only a small portion of its area having an altitude of less than 2,000 feet. The western part is watered by the headwaters of the Yuba

River, flowing toward the Sacramento Valley through deep cañons; the eastern by a few small streams which enter the State of Nevada. A number of small mountain lakes occur on the high table lands where the Sierra spreads out into flats or depressions, Gold Lake, with a length of 4 miles, and a width of 2 miles, being the source of the Middle Fork of the Feather River.

The eastern half of the county, embracing the Sierra proper, has an elevation of over 4,000 feet, and some of its peaks and buttes rise to 6,000 or 8,000 feet, and are covered with snow for several months of the year, the chief mode of Winter travel being with snowshoes. Sierra Valley, situated among these mountains, is 20 miles long and 10 miles wide, and contains a number of small farms. Owing to its elevation the climate is too severe for ordinary grain crops, but rye and the hardier forage grasses succeed, and stock breeding is pursued with fair success. The inroads of the grasshopper (*Oedipoda atrox*) are sometimes severely felt in this region. The valley is not well watered. Produce is hauled to Truckee for sale or shipment. The upper foothills on the west, with their elevation of from 2,000 to 4,000 feet, cover the larger part of the western half of the county, and embrace a rugged and broken country, and, together with the small area of lower foothills, is interspersed with small red and gravelly valleys, which afford the only farming lands.

The county is well timbered with sugar and yellow pines, fir, cedar, spruce, and much wild plum; but the lower foothills have chiefly a growth of scrubby oak. The chief industries of the county are mining and lumbering.

The nearest railroad point to the western section of the county, from which supplies may be obtained, is Nevada City, in Nevada County, on the south, which is connected by the Northern California Railroad with Colfax, and thence by the Central Pacific Railroad with Sacramento and other points.

NEVADA.

(See "Lower Foothills Region.")

PLACER.

(See "Lower Foothills Region.")

EL DORADO.

(See "Lower Foothills Region.")

AMADOR.

(See "Lower Foothills Region.")

ALPINE.

Area, 730 square miles. All Sierra mountain region.

Alpine County lies upon the summit of the Sierra Range and eastward to the State line, and its surface is described as being but a mass of mountain ranges rising as high as 10,000 feet above the sea, the general level being above 4,000 feet. The eastern half of the county embraces almost the only habitations, and is watered by a number of small streams, the headwaters of Carson River, of Nevada. The

Mokelumne and Stanislaus Rivers rise among the mountains on the west and flow westward, through the foothill countries, into the great valley. Forming the sources of those several streams (on the east) are numerous small lakes, the most of them situated on the summit of the mountain, where it spreads out into a sort of table land. Many of them are wild and beautiful, being skirted by belts of grass or bordered by plats of lawn-like meadow lands. In some instances they are destitute of these grassy surroundings, being closely hemmed in by dark forests, or shadowed by impending cliffs of granite. There are also in this county many grassy, well watered valleys, rendered the more attractive by their rugged and desolate surroundings. Into these the herdsmen from either side drive their cattle for pasturage during the Summer, removing them as Winter approaches, the snows in the higher of these valleys always falling to an immense depth.

Alpine County abounds in spruce and pine forests, the timber on the higher Sierra being of large size, while that on the eastern slope and beyond is of inferior quality. Three fourths of the county is thus heavily timbered. Mining and lumbering are the chief industries, and there is very little farming done in the county. Diamond Valley, in the northeast, seems to be the only one in which lands are cultivated, even to a small extent, the crops being wheat, barley, hay, oats, and potatoes. The Faith, Hope, and Charity Valleys, of the northwest, are inhabited by stock raisers and dairymen during the Summer months, and have an elevation of 7,500 feet above the sea.

CALAVERAS.

(See "Lower Foothills Region.")

TUOLUMNE.

(See "Lower Foothills Region.")

MARIPOSA.

(See "Lower Foothills Region.")

MONO.

Area, 3,400 square miles. Sierra mountains, with some valleys, all.

Mono County lies along the eastern border of the State, and is separated from other counties by the high Sierra chain of mountains on the west, which, with an elevation of 13,000 feet, forms a most effectual barrier to transportation in that direction.

A central feature of the county is Mono Lake, covering a length of 14 miles and a width of 9 miles, whose water is extremely bitter and saline. The northern part of the county is scantily watered by two or more forks of Walker's River, which here have their rise and unite in Nevada, after flowing through deep cañons. On the south are the headwaters of Owen's River, which is the most prominent stream of the county in that portion.

The general altitude of the county is about 6,000 feet, and, besides the Sierra on the west, the eastern part is traversed by the White and Inyo chain of mountains.

The only lands suitable for tillage are situated in the valleys among the Sierra, in small alluvial tracts along Owen's River, and on the two forks of Walker's River. The valleys chiefly in cultivation are Big Meadows and Antelope, each about 15 miles long and 5 miles wide. There is also a little land on the small streams of Mono Lake and at the foot of the Sierra, where the streams have formed an alluvial delta extending a short distance out on the plain. Irrigation is necessary to insure good crops on all of the lands. The country, however, east of the Sierra to the State line, is a desert, volcanic in character, abounding in alkali beds, salt pools, and barren table lands, and destitute of timber, excepting a few scattering willow trees. There is much spruce and pine on the high Sierras, the slopes being well timbered.

Mining is the chief industry of the county, and several large camps are located at the most important mines.

There are comparatively few roads as yet in the county. One, by way of which the mail is carried, leads from Aurora, Nevada, through Blind Springs and Owensville in Mono County, to Independence, in Inyo County. A wagon road which cost a large amount of money has been constructed from Bridgeport, the county seat, over the mountains, by way of the Sonora Pass, to Stockton. Bridgeport may also be reached by way of the Central Pacific Railroad and Aurora.

INYO.

Area, 8,120 square miles. Sierra mountains, 1,950 square miles; valleys, 640 square miles; desert lands, 553 square miles.

Inyo County lies between the State line and the high Sierra Nevada Mountains, the western boundary being along the summit of the latter, at an elevation of several thousand feet above the general level of the rest of the county, and 8,000 or 10,000 above the sea, some of the peaks rising to 14,000 and 15,000 feet. Parallel with the Sierra is the White and Inyo chain, lying centrally in the county, and still eastward the shorter chains of Telescope, Panamint, Amargosa, and others.

The only stream of importance is Owen's River, on the west, watering a long valley of the same name lying between the Sierra and Inyo Mountains. This river has its source in Mono County on the north, and flows for nearly 100 miles southward into Owen's Lake, a large body of salt water about 22 miles long, 8 miles broad, and of great depth, which has no outlet. The Amargosa River on the southeast rises in Nevada, flows southward at first across this county into San Bernardino County for a short distance, and then turns northwest and disappears in Death Valley.

The only tillable lands in the county are embraced in the valleys along Owen's River, at the foot of the Sierra, in a belt varying from a few rods to a mile or more in width, and having an alluvial soil, which is very productive under irrigation. Round Valley, on the extreme north, was first cultivated in 1865, and now produces wheat, oats, barley, etc.; it lies at the foot of the Sierra, at an elevation of 4,000 feet, and is 6 miles long and 3 miles wide. Long Valley has a length of 15 miles, and is chiefly a stock range; but numerous farming settlements occur southward to Independence. All of the country southward from Lone Pine Post Office (15 miles south of Independence), and eastward from Owen's River, and embracing the greater part of the county, is a treeless and sandy desert, without water and almost destitute of grass, and is the upper part of the great Mojave

Desert of the south. It is interspersed with isolated mountain chains and peaks, containing patches of piñon and juniper trees, but otherwise barren. Their valleys have no meadow lands, but several contain extensive alkali flats, beds of salt, and saline and hot springs. A prominent and well known feature of the southeastern part of the county is the Death Valley, which has a length of 45 miles and a width of 15 miles, and sinks from 150 to 200 feet below the level of the sea.

There is but comparatively little in the county under cultivation.

Supplies are transported across the desert from Mojave, the nearest railroad station, by means of the peculiar wagon of the West, known as the "prairie schooner."

FRESNO.

(See "Great Valley Region.")

TULARE.

(See "Great Valley Region.")

KERN.

(See "Great Valley Region.")

CHAPTER V.

IN COMPLIANCE WITH THE LAW.

In the preceding chapter the State was considered descriptively; in this it should have been taken up statistically. The method by which this was attempted to be done was in strict compliance with the provisions of the law by which the bureau was created. The Assessors of the various counties were appealed to, through a circular, of which the following is a copy, to furnish certain classes of information, with which it was supposed they should be conversant, or which they, at least, could readily obtain. The circular referred to ran as follows:

CIRCULAR.

Office of the State Bureau of Labor Statistics,
Corner of Geary and Dupont Streets,
San Francisco, ———, 188—.

To —— ———

Dear Sir: The Legislature last Winter created the Bureau of Labor Statistics. The law is of the most comprehensive character, embracing within its broad scope almost every industry, trade, and interest common to civilized society; in fact, it imposes a very grave responsibility on the chief officer and his assistant, while but a limited appropriation is made to carry out its provisions. Hence, we are constrained to call upon the people, through their representatives in office throughout the State, to furnish us with such information as the importance of this work demands and the *law* provides we shall secure. Should we be baffled in this, the *report* expected to be sent forth from this office will not come up to the standard that should naturally be expected.

When you consider the vast amount of correspondence, the number of officials we *must* communicate with—such as the various State officials, railroad officials, City and County Assessors, County Clerks, mining superintendents and operators, labor unions, manufacturers of every commodity imaginable, farmers, educational institutions, trades assemblies, organized protective labor and beneficial societies, artisans, producers, merchants, and, in fact, all institutions calculated to throw any light on the condition of the people of this State in a social, political, sanitary, commercial, or moral sense—the magnitude of this effort is self-apparent, and the limited advantages we enjoy almost compel us to forego the task, were we not fully cognizant of the generous response that will be given our questions by all who are interested in the future welfare of California.

We are already in communication with the heads of the various departments of the National Government, particularly with Hon. Joseph Nimmo, Jr., Chief of the Bureau of Statistics of the Treasury Department, and with each of the Labor Bureaus of the different States of the Union. Much valuable information has been secured through those agencies.

A compliance, therefore, with the questions we present to you will enable us, ere the next Legislature convenes, to lay before that body some very valuable data, if we are to judge from what is daily being received from the sources above alluded to.

The bureau is clothed with ample authority under the law to compel answers, but it much prefers to depend upon the good will of the people. It may not be out of place here to insert Sections 4, 5, 7, and 8, which are as follows, viz.:

Sec. 4. It shall be the duty of all officers of State departments, and the Assessors of the various counties of the State, to furnish, upon the written request of the Commissioner, all the information in their power necessary to assist in carrying out the objects of this Act; and all printing required by the bureau in the discharge of its duty shall be performed by the State Printing Department, and at least three thousand (3,000) copies of the printed report shall be furnished the Commissioner for free distribution to the public.

Sec. 5. Any person who willfully impedes or prevents the Commissoner or his deputy in the full and free performance of his or their duty, shall be guilty of a misdemeanor, and upon conviction of the same shall be fined not less than ten (10) nor more than fifty (50) dollars, or imprisoned not less than seven (7) nor more than thirty (30) days in the county jail, or both.

SEC. 7. The Commissioner shall have power to send for persons and papers, whenever in his opinion it is necessary, and he may examine witnesses under oath, being hereby qualified to administer the same in the performance of his duty, and the testimony so taken must be filed and preserved in the office of said Commissioner; he shall have free access to all places and works of labor.

SEC. 8. The Commissioner shall appoint a deputy, who shall serve the same time and have the same powers as the said Commissioner, as set forth in the preceding sections.

Your own judgment teaches you that it is not an uncommon thing for Legislatures to pass laws of an impracticable character. This is most frequently due to a lack of knowledge of FACT. Hence, we conclude that what is most necessary to the ordinary legislator is INFORMATION. To secure a knowlege of our State and its wonderful resources, as well as its great productions, is one of the principal objects of this bureau, and, although the appropriation is small, by the assistance of each officer applied to, we will be enabled to lay before our law-making powers a proper exhibit of what our State *is*, and leave to *them* the duty of enacting such laws as are best calculated to make her what she *ought to be:* the first in the great sisterhood of States.

Besides, we desire that our report should compare favorably with those of other bureaus of a similar character throughout the Union, and to succeed in that direction we are *entirely* dependent upon the promptness and readiness of the officials, newspaper proprietors, and the people we address, to comply with our request.

It should be a matter of pride with every one *sincerely* interested in the future of California to contribute their share to this meritorious work, as they will find "at the end of two years that the matter thus accumulated will prove far more valuable than tons of campaign speeches."

We might add, also, that should the officers of any county fail or refuse to respond to our inquiries, *the people of the whole State* will regret to see that county exhibiting a blank space in the statistical tables.

And still further we must say that, while the bureau will be obliged to inquire considerably into details of private business in order to *get at the aggregate wealth of the State, the private affairs of individuals will be kept strictly confidential.*

Or, in the language of Hon. John Collett, formerly Chief of the Bureau of Labor in the State of Indiana: "For instance, inquiries are made of A, B, C, D, and E, who are, we will say, merchants and manufacturers; what their sales have been during the past year; how much cash sales; how much on time; what the claims outstanding; what their *bona fide* indebtedness; how many persons employed, male and female; what wages," etc. Not for the purpose of prying into the private business of each, but for the purpose of showing the aggregate of such business in the State and the several counties of the same. *All these will be destroyed as soon as the total for the county is known.* So with each line of business. This is already done every year on assessment blanks, and every ten years by the United States census takers.

We most respectfully call the attention of all Assessors to Forms 1, 2, 3, 4, 5, 6, 7, and 8, which accompany this circular. We would respectfully request you to hand Form "A" to the different manufacturers or employers of labor, to be answered by them and returned to you; and Form "B" you will please hand or send to all employés in the various branches of industry, including agriculture, to be also answered by them and returned to you.

In conclusion, we appeal to the press of the entire State to assist us all they can in furthering the objects of this bureau in its endeavor to secure a knowledge of the relative rates of wages paid in this State, so as to enable us to compare with similar results in other States of the Union, as such knowledge will prove beneficial to all classes of our people.

Trusting, therefore, that you will generously respond to our inquiries, I have the honor to subscribe myself,

Your obedient servant,

JOHN S. ENOS, Commissioner.

Attached to this circular, and, indeed, bound up with it in convenient fashion, were eight forms in blank, to be filled out by the Assessor. Three hundred and twenty-five questions were asked, and that the range of information sought was of the most comprehensive character possible, you may satisfy yourselves by glancing at the reproduction of these forms, appended to these remarks. You will see there that the statistical details sought conform to the classification indicated by the Legislature. Agriculture, for instance, was taken up, a table prepared at great pains, and statistics sought concerning the agricultural lands of the county, their price and extent, the number of farms and their size, those that are owned and those that are rented, the value of the improvements, the character of the implements used, and the number of labor-saving machines employed.

Regarding agricultural laborers, questions were asked upon the number of farm and road hands employed, their wages, sex, hours, nationality, age, average unemployment, and the sanitary condition of their homes and lodgings.

Next the mechanical and manufacturing industries were taken up, the same elaborate series of inquiries put concerning their number, sex, wages, etc., and a list of industries given that ran from asphaltum works to woolen mills, and back from wineries to awning works.

Mines and miners constituted the next subject, the questions including every description of mines and quarries, together with those relating to number, wages, etc., already twice referred to.

Transportation on land and water was next taken up, and all that related to railroads completed, or under construction; to stage roads, to steamers, and to sailing craft, was asked for, together with the number and condition of drivers, pilots, sailors, stewards, and engineers, who found employment thereon.

In the clerical and all other skilled and unskilled labor, to which the next table is devoted, every branch of employment that has not before been enumerated is embraced. The list is an extended one, taking up advertising agents, chemists, clerks, fishermen, printers, school teachers, and the score of other workers for their daily bread that would come under such a general head.

To all the foregoing tables the special proviso was attached that the reports should relate exclusively to Chinese laborers, and, accordingly, the next form, No. 7, refers wholly to the Mongolian. The questions under this form are directed to their habits—social, moral, and sanitary—what they do, what they earn, and what they spend.

Lastly, inquiries were made concerning the inmates of the jails, and other reformatory institutions found in the county; their number, age, sex, nationality, and employments, being the matters most sought after.

In order that a still more exact idea may be obtained of the means made use of to gather the information referred to, a copy in blank of the eight forms is here attached:

STATE BUREAU OF LABOR STATISTICS.

Statistical Statement made by —— ——, Assessor of —— Township (or County).

Form No. 1.

Relating to Agriculture.

1. How many acres of land (exclusive of town lots) does your county or township contain?
2. How many acres of land (exclusive of town lots) are under cultivation?
3. How many acres of land (exclusive of town lots) are unfit for cultivation?
4. How many acres of land (exclusive of town lots) are timber land?
5. How many acres of land (exclusive of town lots) are open for preëmption?
6. What is the maximum price per acre (exclusive of town lots)?
7. What is the minimum price per acre (exclusive of town lots)?
8. What is the average price per acre (exclusive of town lots)?
9. How many ranches are in your county (or township)?
10. How many ranch owners?
11. How many have from three to ten acres?
12. How many have from ten to twenty-five acres?
13. How many have from twenty-five to fifty acres?
14. How many have from fifty to one hundred acres?
15. How many have from one hundred to two hundred and fifty acres?
16. How many have from two hundred and fifty to five hundred acres?
17. How many have from five hundred to one thousand acres?
18. How many have from one thousand to two thousand five hundred acres?
19. How many have from two thousand five hundred to five thousand acres?
20. How many have five thousand acres and over?
21. How many ranches are worked by owners?
22. How many ranches are worked in shares between owner and renter?
23. How many ranches are worked in shares between owner and laborers?
24. How many ranches are rented?
25. What is the maximum rent per acre?
26. What is the minimum rent per acre?
27. What is the average rent per acre?
28. How many buildings of all kinds (exclusive of city or town buildings) does your county (or township) contain?
29. What is their value?
30. How many miles of fences are in your county (or township)?
31. What is their cost per mile?
32. What is the value of all the agricultural implements in your county (or township)?
33. How many labor-saving agricultural implements are in your county (or township)?
34. What is their value?
35. What is their combined horse (or man) power?
36. What percentage of ranch cultivators in your county (or township) use labor-saving machines?

FORM No. 1—Continued.

Relating to Farm Hands and Road Laborers.

37. How many laborers (Chinese excluded) are employed in agriculture in your county (or township)?
38. What are their ages? From ——, to ——.
39. How many are under fifteen years of age?
40. How many of the laborers are females?
41. What are their ages? From ——, to ——.
42. What are the maximum wages paid (including board) per month?
43. What are the minimum wages paid (including board) per month?
44. What are the average wages paid (including board) per month?
45. What industry of agriculture pays the maximum?
46. What industry of agriculture pays the minimum?
47. How many months in the year are laborers generally employed?
48. When unemployed in agriculture what industry do they pursue to gain a livelihood?
49. What are the maximum hours of labor per diem?
50. What are the minimum hours of labor per diem?
51. What are the average hours of labor per diem?
52. Are those working over the regular hours constituting a day's work, paid extra?
53. If so, how much per hour?
54. If from sickness laborers must abstain from work, are any deductions made from his wages?
55. How many road laborers are in your county (or township)?
56. What is the wages paid to them?
57. What is the laborer's condition in general? Morally, ——; physically, ——; mentally, ——.
58. How many laborers (exclusive of Chinese) are in your county (or township) unemployed?
59. How many of the unemployed are native Americans?
60. How many of the unemployed are foreigners.
61. Their nationality?
62. What are their ages? From ——, to ——.
63. How many under fifteen?
64. How many are females? ——. Their nationality?
65. What are the causes of their idleness? (Please state everything you know about it.)
66. What steps can be taken, or what is necessary, to obtain employment for all in your county (or township)?
67. How do they obtain sustenance and clothing?
68. In what condition are the roads in your county (railroads excluded)?
69. Can you suggest anything that will ameliorate the condition of the laborers and accrue to their benefit?
70. How are the sanitary conditions of the lands in your county?

FORM

Relating to Employés in Mechanical and

Number of Questions	Description of Items.
1	How many asphaltum workers are employed in the whole county (or township)
2	How many awning makers are employed in the whole county (or township)
3	How many employés in agricultural implements in the whole county (or township)
4	How many artificial flowers employés in the whole county (or township)
5	How many bag (cotton) manufacturers in the whole county (or township)
6	How many bag (paper) manufacturers in the whole county (or township)
7	How many bakers in the whole county (or township)
8	How many brewers in the whole county (or township)
9	How many blacksmiths in the whole county (or township)
10	How many boilermakers in the whole county (or township)
11	How many brass molders in the whole county (or township)
12	How many bookbinders in the whole county (or township)
13	How many brick makers in the whole county (or township)
14	How many broom makers in the whole county (or township)
15	How many brush makers in the whole county (or township)
16	How many box (cigar) makers in the whole county (or township)
17	How many box (wood, packing) makers in the whole county (or township)
18	How many cabinet makers in the whole county (or township)
19	How many candle makers in the whole county (or township)
20	How many canneries (fish, fruit, etc.,) employés in the whole county (or township)
21	How many carpenters and joiners in the whole county (or township)
22	How many carpenters (ship) in the whole county (or township)
23	How many carriage and wagon makers in the whole county (or township)
24	How many calkers (ship) in the whole county (or township)
25	How many cement makers in the whole county (or township)
26	How many cigar makers in the whole county (or township)
27	How many confectioners in the whole county (or township)
28	How many coffee and spice mill employés in the whole county (or township)
29	How many coopers in the whole county (or township)
30	How many coppersmiths in the whole county (or township)
31	How many cutlers in the whole county (or township)
32	How many employés in distilleries in the whole county (or township)
33	How many employés in dairies in the whole county (or township)
34	How many employés in glassworks in the whole county (or township)
35	How many glovemakers in the whole county (or township)
36	How many gluemakers in the whole county (or township)
37	How many gunsmiths in the whole county (or township)
38	How many hat and cap makers in the whole county (or township)
39	How many iron molders in the whole county (or township)
40	How many ink and mucilage makers in the whole county (or township)
41	How many locksmiths in the whole county (or township)
42	How many employés in limekilns in the whole county (or township)
43	How many machinists in the whole county (or township)
44	How many marble cutters in the whole county (or township)
45	How many employés in watch factories in the whole county (or township)
46	How many millers in the whole county (or township)
47	How many pattern makers in the whole county (or township)
48	How many employés in paper mills in the whole county (or township)
49	How many potters in the whole county (or township)
50	How many employés in powder mills in the whole county (or township)
51	How many plumbers in the whole county (or township)
52	How many employés in rolling mills in the whole county (or township)
53	How many ropemakers in the whole county (or township)
54	How many saddlers and harness makers in the whole county (or township)
55	How many sailmakers in the whole county (or township)
56	How many salt makers in the whole county (or township)
57	How many sash, door, and blind makers in the whole county (or township)

No. 2.

Manufacturing Industries (Chinese Excluded).

Total Numbers	Hours Constituting a Day's Work.			Sex.		Wages Paid to Males.				Wages Paid to Females.			
	Maximum	Minimum	Average	Males	Females	Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board

Form No. 2—

Number of Questions	Description of Items.
58	How many shingle makers in the whole county (or township)
59	How many shoemakers in the whole county (or township)
60	How many soda works employés in the whole county (or township)
61	How many stonecutters in the whole county (or township)
62	How many tailors in the whole county (or township)
63	How many tanners in the whole county (or township)
64	How many tinsmiths in the whole county (or township)
65	How many upholsterers in the whole county (or township)
66	How many wheelwrights in the whole county (or township)
67	How many wine manufacturers in the whole county (or township)
68	How many willow and woodenware employés in the whole county (or township)
69	How many woolen mill employés in the whole county (or township)
70	How many of the aforementioned professions are unemployed
71	Their nationality
72	Their ages? From
73	The causes
74	How do they manage to subsist

Continued.

Total Numbers	Hours Constituting a Day's Work.			Sex.		Wages Paid to Males.				Wages Paid to Females.			
	Maximum	Minimum	Average	Male	Female	Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board
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FORM

Relating to Mines and

Number of Questions	Description of Items.
1	How many asphaltum mines are in your county (or township)
2	How many asphaltum miners are in your county (or township)
3	How many coal mines are in your county (or township)
4	How many coal miners are in your county (or township)
5	How many gold placer mines are in your county (or township)
6	How many gold placer miners are in your county (or township)
7	How many gold quartz mines are in your county (or township)
8	How many gold quartz miners are in your county (or township)
9	How many gold hydraulic mines are in your county (or township)
10	How many gold hydraulic miners are in your county (or township)
11	How many silver mines are in your county (or township)
12	How many silver miners are in your county (or township)
13	How many gravel mines are in your county (or township)
14	How many gravel miners are in your county (or township)
15	How many iron mines are in your county (or township)
16	How many iron miners are in your county (or township)
17	How many marble quarries are in your county (or township)
18	How many marble miners are in your county (or township)
19	How many quicksilver mines are in your county (or township)
20	How many quicksilver miners are in your county (or township)
21	How many salt mines are in your county (or township)
22	How many salt miners are in your county (or township)
23	How many granite stone quarries are in your county (or township)
24	How many granite stone miners are in your county (or township)
25	How many limestone quarries are in your county (or township)
26	How many limestone miners are in your county (or township)
27	How many sandstone quarries are in your county (or township)
28	How many sandstone miners are in your county (or township)
29	How many mines not enumerated above are in your county (or township)
30	If so, state whether worked or not, wages paid, etc.
31	How many miners in your county are unemployed?
32	The causes?
33	Their ages and nationality?

No. 3.

Miners (*Chinese Excluded*).

Number of Mines	Number of Miners	Hours Constituting a Day's Work.			Number of Months Employed in the Year	Wages per Day.			
		Maximum	Minimum	Average		Maximum	Minimum	Average	With or Without Board

FORM

Relating to Transportation on Land

Number of Questions	Description of Items.
1	How many miles of steam railroads in operation are in your county
2	How many employés of all kinds on above are in your county
3	How many miles of unfinished steam railroads are in your county
4	How many men are employed thereon in your county
5	How many miles of street railroads (horse-power) are in your county
6	How many men are engaged thereon in your county
7	How many conductors are engaged thereon in your county
8	How many drivers are engaged thereon in your county
9	How many miles of macadamized roads are in your county
10	How many men are engaged thereon in your county
11	How many stage drivers in your county
12	How many teamsters hauling, etc., in your county
13	How many draymen hauling, etc., in your connty
14	How many agents, railroad, stage, express, and steamboats in your county
15	How many men are engaged in express companies in your county
16	How many steamboats and sailing vessels of all kinds in your county
17	How many captains thereon in your county
18	How many pilots thereon in your county
19	How many pursers thereon in your county
20	How many engineers thereon in your county
21	How many freight clerks thereon in your county
22	How many mates thereon in your county
23	How many stewards thereon in your county
24	How many cooks thereon in your county
25	How many firemen thereon in your county
26	How many sailors thereon in your county
27	How many men generally engaged in transportation are out of employment in your county
28	For what causes
29	Their ages and nationalities
30	How do they subsist

No. 4.

and Water (Chinese Excluded).

Miles of Roads	Number of Men	Average Hours per Day	Average Number of Months Engaged per Annum	Wages Paid.			
				Maximum	Minimum	Average	With or Without Board

FORM

Relating to Clerical and all other Skilled and Unskilled

Number of Questions	Description of Items.
1	How many auctioneers are employed in your county
2	How many advertising agents are employed in your county
3	How many assayers and chemists are employed in your county
4	How many barbers are employed in your county
5	How many bookkeepers in all departments in your county
6	How many bricklayers in your county
7	How many clerks are employed in banking institutions in your county
8	How many clerks are employed in insurance offices in your county
9	How many clerks are employed in lawyers' offices in your county
10	How many clerks are employed in general merchandising in your county
11	How many clerks are employed in county and town governments in your county
12	How many cooks are employed in your county (or town)
13	How many dentists are employed in your county (or town)
14	How many draughtsmen are employed in your county (or town)
15	How many draymen are employed in your county (or town)
16	How many dress and cloak makers in your county (or town)
17	How many engravers in your county (or town)
18	How many engineers (civil) in your county (or town)
19	How many engineers (stationary engines) in your county (or town)
20	How many engineers (mining) in your county (or town)
21	How many florists and gardeners in your county (or town)
22	How many fishermen in your county (or town)
23	How many glaziers in your county (or town)
24	How many journalistic editors in your county (or town)
25	How many journalistic reporters in your county (or town)
26	How many hod carriers in your county (or town)
27	How many hostlers in your county (or town)
28	How many laundrymen in your county (or town)
29	How many longshoremen in your county (or town)
30	How many lumbermen in your county (or town)
31	How many milliners in your county (or town)
32	How many painters (house) in your county (or town)
33	How many fresco painters are employed in your county
34	How many plasterers are employed in your county
35	How many printers are employed in your county
36	How many photographers are employed in your county
37	How many school teachers are employed in your county
38	How many seamstresses are employed in your county
39	How many servants (domestic) are employed in your county
40	How many telegraph operators are employed in your county
41	How many telegraph messenger boys are employed in your county
42	How many waiters (restaurant, hotel, etc.,) are employed in your county
43	How many watchmakers are employed in your county
44	How many well-borers (artesian) are employed in your county
45	How many well-borers (oil) are employed in your county
46	How many wood carvers and turners are employed in your county
47	How many wood cutters are employed in your county
48	How many artisans not above enumerated are unemployed in your county
49	How many of foregoing mentioned professions are employed? Males ______ females ______; nationality ______
50	From what cause
51	How do they manage to subsist

No. 5.

Labor not before Enumerated (Chinese Excluded).

Total Number	Sex.		Hours Constituting a Day's Work.			Average No. Months engaged per Annum	Wages Paid to Males.				Wages Paid to Females.			
	Males	Females	Maximum	Minimum	Average		Maximum	Minimum	Average	With or without Board	Maximum	Minimum	Average	With or without Board

Form No. 6.

Miscellaneous.

1. What is the total value of all lands and town lots in your county (or township)?
2. What is the total value of all the buildings in the towns of your county (or township)?
3. What is the total value of all the machineries used for mechanical and manufacturing purposes?
4. What is the total value of all materials used in manufactures in your county (or township)?
5. To what extent does the apprenticeship system prevail in the various skilled industries in your county (or township)?
6. Are any trades unions in your county?
7. Name them.
8. What percentage of wage-workers belong to them?
9. How are the sanitary conditions of the workshops of mechanics and manufacturers?
10. How are the sanitary conditions of the dwellings of the wage-workers?
11. What percentage of dwellings are owned by them?
12. What is the cost of rent of dwellings generally occupied by the wage-workers?
13. What is the cost of rent of rooms generally occupied by the wage-workers?
14. What is the cost of food or board per month?
15. What is the cost of fuel? Wood? Coal?
16. What is the cost of water for household purposes per month?
17. What is the cost of water for irrigation purposes?
18. How many poor people live in your county (or township)? Males? Females?
19. Their ages? From?
20. The cause? Nationality?
21. How many rooms do they occupy?
22. What are their conditions? Sanitary? Morally?
23. What suggestions can you make to ameliorate their condition?
24. How many corporations (local) are in your county?
25. Name them.
26. Name capital stock of each.
27. Name cash capital invested in them.
28. Total amount of hands employed in each?

Form No. 7.

Relating to Chinese (Exclusively).

1. How many Chinese are in your county (or township)? Males? Females?
2. What are their conditions?
3. What are their social habits?
4. What are their sanitary habits?
5. How many of them are married?
6. How many of them are employed?
7. How many of them are domestic servants?
8. What wages are paid to domestic servants per week? Per month? With or without board?
9. How many of them are cooks?
10. What wages are paid to them per week? Per month? With or without board?
11. How many are laundrymen?
12. What wages do they earn per week? Per month? With or without board?
13. How many Chinese laundries are in your county (or township)?
14. How many Chinese do they employ in your county (or township)?
15. How many Chinese cultivate the soil in your county (or township)?
16. What wages are paid them per month with board? Without board?
17. How many Chinese miners are in your county (or township)?
18. What wages do they earn? With or without board?
19. How many of them are employed in manufactures of all kinds?
20. Name the various industries and number employed in each of them?
21. What are the wages paid them in each of the industries employed?
22. What is the gross amount paid them yearly in every branch in which they are engaged?
23. How much do they expend for rent, either per head or collectively, per month?
24. How much do they expend for food, per head or collectively, per month?
25. What percentage of the food are home products?
26. What percentage of the food are imported from foreign countries?
27. How much do they expend for clothing per head each year?
28. What percentage of the clothing is of American manufacture?
29. What percentage of the clothing is imported?
30. How much of their yearly earnings are sent out of the country?
31. What percentage to the amount of earnings?
32. To what extent does their employment come in competition with the white industrial classes?

Form No. 8.

Relating to Inmates of Jails and other Reformatory Institutions.

1. How many inmates are in your county jail and other reformatory institutions in your county? Males? Females? Chinese?
2. What are their ages? Males? Females? Chinese?
3. What are their nationalities?
4. What are their conditions and sanitary habits?
5. How many of the inmates are employed?
6. What does their employment consist of? Males? Females? Chinese?
7. To what extent does their employment come in competition with the labor of mechanics, artisans, and all other white laborers outside of reformatory institutions?

While I do not wish to be considered fault-finding, or to impute a lack of proper zeal to the County Assessors, I am forced to report that the result of these inquiries has been most unsuccessful and useless. I did not anticipate absolute success, nor did I look for such a worthless outcome. Out of the 52 counties, answers indeed were received but from 41. Of this number, 10 reports only were passable, 4 only were good, and 27 so bad that to reprint them, would not only be an incumbering of the State Printer's office, for which there could be no excuse, but would be filling this report with waste paper, and inviting your attention to a series of fiascos from which nothing could be learned except a lesson of incapacity. Lest it should be thought that these strictures are too severe, allow me to quote from one or two of the returns.

One of our County Assessors gives as the total extent of information concerning the mining industry of his county, that there are 2 coal mines, 30 coal miners, 40 gold placer mines, employing 150 miners, 75 gold quartz mines, employing about 1,000 miners, and 2 marble quarries, employing 6 quarrymen. The value of these answers, compared with that sought by the questions, may be imagined. There are 2,000 Chinese in his county, he states, of which 100 are servants, 30 are cooks, 20 are laundry bosses, 100 are laundrymen, 25 are cultivators, and 1,500 are miners, leaving 225 to be accounted for, and presenting figures so suspiciously like guesswork, that they are entirely unreliable. To Form No. 8, relating to the inmates of jails, etc., his solitary answer is that there are 4 prisoners. Everything in the way of comparative data is omitted, while the tables referring to wages, sex, and day labor, do not contain a single figure.

It must not, however, be supposed that this is an exceptional case, for W. S. B. Wilson, the Assessor of Butte County; W. R. Terry, the Assessor of Calaveras County; J. M. Stow, the Assessor of Contra Costa County; W. J. Hutchinson, Assessor of Fresno; J. C. Irwin, of Inyo; S. J. Westlake, of Monterey; John Kean, of Napa; J. M. Garnett, of San Joaquin; C. W. Kingsbury, of Shasta; J. A. Conaway, of Ventura; R. M. Huston, of Yolo; and Lewis Wilder, of Yuba, have returned their reports with these most important tables as blank as when they were sent to them.

In cases where a single figure has been inserted—and in nine cases out of ten the figures have been placed on the wrong page—the answer is most astonishing. According to the Yuba return, for instance, there is but one baker, one cigar maker, one blacksmith, two millers, one tanner, two upholsterers, and one employed in a woolen mill, in the whole county, while, if the report is to be believed, Yuba County does not possess a single bookbinder, cabinet maker, cooper, dairyman, or stonecutter. Even more astonishing than this, if blank means none, there is not a mine, a quarry, a railroad, a stage road, a teamster, an auctioneer, a journalist, a clerk, or a milliner, in Yuba County. The lands have no value, food has no cost, houses no rate of rent, nor corporations any capital. Moreover, there are no Chinese, no jails, and no prisoners. It is not surprising to find that Mr. Wilder, whose information on Yuba County is so original, should have the assurance to suggest, as a plan for ameliorating the condition of laborers, about whom he knows so much, that there should be "a paternal government, with a constitution so framed that the aggregated stealings from labor shall be divided up for the benefit of all the American family every five years."

Mr. Huston, of Yolo, contents himself with scrawling across the page relating to the mechanical, manufacturing, mining, transportation, and clerical industries, that he has "no data" on the subject.

Mr. Conaway, of Ventura, gives, as a reason for his nullity of information, that he is "very busy," and generously refers me for other statistics to his report to the State Board of Equalization, apparently oblivious of the fact, that the figures in that report are not at all what I have asked for.

According to Mr. McKinley, District No. 3, of Placer County, must be a very peculiar place. It contains no agricultural land, has no road laborers, nothing approaching a manufacturing industry, whilst its population consists of 250 gold placer miners, 2 stage drivers, 5 teamsters, 3 chemists, 3 clerks, 15 lumbermen, and 129 Chinese. Notwithstanding this, there are 13 school teachers, who must find it a puzzle to fill their benches.

Even of such a county as San Joaquin, the information given is absolutely nil; not 10 per cent of the questions being answered at all, and not 1 per cent being answered according to the required form.

The laborers of Napa County, according to Mr. Kean, are principally Irish; idleness is caused, strangely enough, by there not being work for all; he cannot suggest anything that would ameliorate the condition of the laborer, and confesses that it is a mystery how he obtains sustenance and clothing. This Assessor not only fails to answer nearly all the questions put him, but thinks that jocoseness is in place, and to the question relating to the subsistence of one class of laborer, answers that it must be "by eating!"

Mr. Westlake, of Monterey, freely confesses, in large characters written across the pages, that he "don't know" anything about the wage-earners, or the industrial condition of his county.

These extracts have not been invidiously selected, nor have the particular reports been referred to because they are exceptionally bad. They are, indeed, fair samples of the remarkable result attending the endeavors of the bureau to collect the information which the Legislature had in view. I say "endeavors" because it has by no means been a single application that has been made to the Assessors. In some cases at least a dozen communications, explanatory and urgent, have been sent to the negligent officials, but all without avail.

The four reports which I have referred to as good are those sent in by T. V. Mathews, Assessor of Santa Cruz County; G. W. Lewis, Assessor of Sonoma County; G. W. Cameron, Assessor of Stanislaus County; and L. A. Spitzer, Assessor of Santa Clara—the last named "return" having been given to an Assessor to aid him in making his report and was never returned.

These three reports will be found reproduced at the close of this chapter, and will show what interesting and valuable documents the forms present when filled in by officials of intelligence, earnestness, and zeal.

The serious question arises here, since the present trial has been a failure, what course must be adopted to secure the information desired? It is true that the law makes such full compliance with the requests of the bureau a matter of duty; but, at the same time, it must be remembered that the Act limits this information to that which it is "in the power" of the Assessors to make. As a matter of fact and of experience—and I say it in a non-critical spirit—the information which the forms call for is not such as the County Assessors could conveniently secure, and, as has been seen, they have evidently not considered it their duty to secure it at all.

I am convinced that the only way to obtain the statistics desired—statistics that shall be full, ample, correct, fresh, and intelligent—will be by personal inspection and report of the Commissioner, or his authorized representative. That such personal collection of data has been impossible during the past two years, and under the forced economical administration of the bureau, you will, of course, appreciate; and I commend it to your honorable attention whether the plan of visiting inspection, which I have indicated, and which I earnestly advocate, is not worthy of being put in practice.

Statistical Statement made by G. W. Cameron, Assessor of Stanislaus County.

FORM NO. 1.

Relating to Agriculture.

1. How many acres of land (exclusive of town lots) does your county contain? 966,000.
2. How many acres of land (exclusive of town lots) are under cultivation? 629,000.
3. How many acres of land (exclusive of town lots) are unfit for cultivation? 225,000.
4. How many acres of land (exclusive of town lots) are timber land? 100,000; fuel only.
5. How many acres of land (exclusive of town lots) are open for preëmption? See United States Land Office.
6. What is the maximum price per acre (exclusive of town lots)? $100.
7. What is the minimum price per acre (exclusive of town lots)? $2 50.
8. What is the average price per acre (exclusive of town lots? $24.
9. How many ranches are in your county? 1,245.
10. How many ranch owners? 943.
11. How many have from three to ten acres? 20.
12. How many have from ten to twenty-five acres? 33.
13. How many have from twenty-five to fifty acres? 16.
14. How many have from fifty to one hundred acres? 54.
15. How many have from one hundred to two hundred and fifty acres? 241.
16. How many have from two hundred and fifty to five hundred acres? 223.
17. How many have from five hundred to one thousand acres? 168.
18. How many have from one thousand to two thousand five hundred acres? 136.
19. How many have from two thousand five hundred to five thousand acres? 31.
20. How many have five thousand acres and over? 21.
21. How many ranches are worked by owners? 75 per cent.
22. How many ranches are worked in shares between owner and renter? 25 per cent.
23. How many ranches are worked in shares between owner and laborers? None.
24. How many ranches are rented? About one fourth.
25. What is the maximum rent per acre? Cash, $2 50, of one third grain.
26. What is the minimum rent per acre? From one fourth to one half grain.
27. What is the average rent per acre? One fourth of all grain.
28. How many buildings of all kinds (exclusive of city or town buildings) does your county contain? 1,245 sets buildings.
29. What is their value? $100,000.
30. How many miles of fences are in your county? 1,800, or thereabout.
31. What is their cost per mile? $270.
32. What is the value of all the agricultural implements in your county? $421,000.
33. How many labor-saving agricultural implements are in your county? All.
34. What is their value? $275,000.
35. What is their combined horse (or man) power? 8,350.
36. What percentage of ranch cultivators in your county use labor-saving machines? 80 per cent.

Relating to Farm Hands and Road Laborers.

37. How many laborers (Chinese excluded) are employed in agriculture in your county? 2,150.
38. What are their ages? From 16 to 65.
39. How many are under 15 years of age? Unknown.
42. What are the maximum wages paid (including board) per month? $100.
43. What are the minimum wages paid per month? $20.
44. What are the average wages paid (including board) per month? $30.
45. What industry of agriculture pays the maximum? Skilled thrashers.
46. What industry of agriculture pays the minimum? Gardeners.
47. How many months in the year are laborers generally employed? Six.
48. When unemployed in agriculture what industry do they pursue to gain a livelihood? Cut wood, mine, and work for lumbermen. Small number of tramps. Some go to Monterey.
49. What are the maximum hours of labor per diem? 13.
50. What are the minimum hours of labor per diem? 9.
51. What are the average hours of labor per diem? 11.
52. Are those working over the regular hours constituting a day's work paid extra? No.
53. If so, how much per hour? Nary cent.
54. If from sickness laborers must abstain from work, are any deductions made from his wages? Certainly.
55. How many road laborers are in your county? 50.
56. What is the wages paid to them? $2 and board themselves.
57. What is the laborer's condition in general? Morally, average standard; physically, good; mentally, perfectly sane.
58. How many laborers (exclusive of Chinese) are in your county unemployed? All are employed, except about 100 gamblers and pimps.
59. How many of the unemployed are native Americans? One third.
60. How many of the unemployed are foreigners? Two thirds.
61. Their nationality? Don't know.
62. What are their ages? From 15 to 50.
63. How many under fifteen? 20.
64. How many are females? 25 prostitutes. Their nationality? 50 of Irish, 30 of mixed, and 20 of Spanish.
65. What are the causes of their idleness? (Please state everything you know about it.) Aside from prostitutes there are not five idle women in the county who have no support.
66. What steps can be taken, or what is necessary, to obtain employment for all in your county? Doing very well now.
68. In what condition are the roads in your county (railroads excluded)? Good.
69. Can you suggest anything that will ameliorate the condition of the laborers and accrue to their benefit? This is a farming community. Laborers get good wages, good food, healthful generally, and all find employment that seek it.
70. How are the sanitary conditions of the lands in your county? Generally light, dry, and healthy; miasmatic in a few spots on the river.

FORM

Relating to Employés in Mechanical and

Number of Questions	Description of Items.
3	How many employés in agricultural implements in the whole county
7	How many bakers in the whole county
8	How many brewers in the whole county
9	How many blacksmiths in the whole county
13	How many brick makers in the whole county
18	How many cabinet makers in the whole county
21	How many carpenters and joiners in the whole county
23	How many carriage and wagon makers in the whole county
26	How many cigar makers in the whole county
27	How many confectioners in the whole county
32	How many employés in distilleries in the whole county
33	How many employés in dairies in the whole county
35	How many glovemakers in the whole county
37	How many gunsmiths in the whole county
43	How many machinists in the whole county
46	How many millers in the whole county
51	How many plumbers in the whole county
54	How many saddlers and harness makers in the whole county
59	How many shoemakers in the whole county
60	How many soda works employés in the whole county
62	How many tailors in the whole county
64	How many tinsmiths in the whole county
65	How many upholsterers in the whole county
66	How many wheelwrights in the whole county

FORM

Relating to Mines and

Number of Questions	Description of Items.
6	How many gold placer miners are in your county
10	How many gold hydraulic miners are in your county
20	How many quicksilver miners are in your county

No. 2.

Manufacturing Industries (Chinese Excluded).

Total Number	Hours Constituting a Day's Work.			Sex.		Wages Paid to Males.				Wages Paid to Females.			
	Maximum	Minimum	Average	Male	Female	Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board
50	10		10	50		$4 00	$2 50	$3 25	Without				
2	10		10	11		2 00							
11	10		10	11		1 50			With				
25	10			25		3 00	1 50	2 25					
5	10		10	5		2 00		2 00					
6	10		10	6		2 00			Without				
50	10		10	50		4 00	2 00	3 00					
20	10		10	20		4 00	2 00	3 00					
2	10		10	2									
2	10		10	1	1								
8	10		10	8		1 00		1 00	With				
12	14		14	12		1 00		1 00					
12	10		10	1	1	1 00		1 00					
3	10		10	3									
4	10		10	4		3 00							
12	11		11	12		2 00							
10	10		10	10		3 00	2 50						
14	10		10	14		2 50							
15	10		10	15		2 50			Without				
2	10		10	2		1 50							
12	10		10	12		2 00							
8	10		10	8		3 00	2 50	2 75					
6	10			6		3 00	2 00	2 50					
20	10		10	20		3 00		2 00					

No. 3.

Miners (Chinese Excluded).

Number of Mines	Number of Miners	Hours Constituting a Day's Work.			Number of Months Employed in the Year	Wages per Day.			
		Maximum	Minimum	Average		Maximum	Minimum	Average	With or Without Board
20	40	10			3	$2 50	$1 50	$2 00	Without
1	4	10			6	3 00	1 50	2 00	Without
5	3	10			2	2 50	1 50	2 00	

FORM

Relating to Transportation on Land

Number of Questions	Description of Items.
1	How many miles of steam railroads in operation are in your county
2	How many employés of all kinds on above are in your county
11	How many stage drivers in your county
12	How many teamsters hauling, etc., in your county
13	How many draymen hauling, etc., in your county
15	How many men are engaged in express companies in your county

FORM

Relating to Clerical and all other Skilled and Unskilled

Number of Questions	Description of Items.
1	How many auctioneers are employed in your county
4	How many barbers are employed in your county
5	How many bookkeepers in all departments in your county
6	How many bricklayers in your county
7	How many clerks are employed in banking institutions in your county
10	How many clerks are employed in general merchandising in your county
11	How many clerks are employed in county and town governments in your county
12	How many cooks are employed in your county (or town)
13	How many dentists are employed in your county (or town)
16	How many dress and cloak makers in your county (or town)
19	How many engineers (stationary engines) in your county (or town)
21	How many florists and gardeners in your county (or town)
23	How many fishermen in your county (or town)
24	How many journalistic editors in your county (or town)
25	How many journalistic reporters in your county (or town)
26	How many hod carriers in your county (or town)
27	How many hostlers in your county (or town)
31	How many milliners in your county (or town)
32	How many painters (house) in your county (or town)
34	How many plasterers are employed in your county
35	How many printers are employed in your county
36	How many photographers are employed in your county
37	How many school teachers are employed in your county
39	How many servants (domestic) are employed in your county
40	How many telegraph operators are employed in your county
41	How many telegraph messenger boys are employed in your county
42	How many waiters (restaurant, hotel, etc.,) are employed in your county
43	How many watchmakers are employed in your county
47	How many woodcutters are employed in your county
49	How many of foregoing mentioned professions are unemployed? None idle any length of time except sports, pimps, and gamblers.

No. 4.

and Water (Chinese Excluded).

Miles of Roads	Number of Men	Average Hours per Day	Average Number of Months Engaged per Annum	Wages Paid. Maximum	Wages Paid. Minimum	Wages Paid. Average	Wages Paid. With or Without Board
3							
12	12	16	12	$5 00	$1 50	$3 50	
	3	10	12				
	14	14	12				
	10	14	12	40 00			
	11	14	12				

No. 5.

Labor not before Enumerated (Chinese Excluded).

Total Number	Sex.		Hours Constituting a Day's Work.			Average No. of Months Engaged per Annum	Wages Paid to Males.				Wages Paid to Females.			
	Males	Females	Maximum	Minimum	Average		Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board
3	3					12								
20	20			12		12		$40 00						
40	40		12	8	10	12	$100 00	50 00	$75 00					
10	10		10	8		6	4 00	3 00	3 50					
3	3		10		9	12	5 00	4 00	4 50					
80	80		12			12	100 00	50 00	75 00					
9	9		8			12	125 00	40 00	100 00					
20	20		12			12	50 00	20 00	40 00	*				
4	4		10			12								
20		20			10	12	2 50	1 00	1 50	†				
6	6		10			8	4 00	2 00	3 00					
1	1		10			12								
2	2		8			12								
5	5													
5	5													
12	12		10			6	2 00			†				
14	14		12			12	1 25			†				
6		6	10			12					$2 00	$1 50	$1 75	
20	20		10			6	2 50	1 50	2 00	†				
6			10			3	3 00	2 50	3 00					
12	12		10			12	3 00		2 00					
3	3		10			12								
58	16	42	6	6	6	8	125 00	60 00	75 00	†	80 00	60 00	75 00	
200		200	12			8					20 00	10 00	15 00	*
7	6	1	12			12	50 00	75 00	60 00				60 00	
2	2		12						20 00					
20	15	5	12			12	40 00						20 00	
6	6					12								
50	50		10			4	3 00		2 00					

* With.
† Without.

Form No. 6.

Miscellaneous.

24. How many corporations (local) are in your county?
25. Name them? Modesto Bank, $150,000 paid up; Grange Company, of Modesto, $6,000; Modesto Water Company, $20,000; Odd Fellows' Hall Association, $10,500; Modesto Publishing Company; Modesto Gas Works, $20,000; Labida Grange Company; Farmers' Warehouse Company; Knight's Ferry Ditch Company; San Joaquin Ditch Company; Exchange Company, of Ceres.
27. Name cash capital invested in them? $300,000.
28. Total amount of hands employed in each? See No. 25.

Form No. 7.

Relating to Chinese (Exclusively).

1. How many Chinese are in your county? Males, 700; females, 100.
2. What are their conditions? Nearly all doing well in their way. They find employment easily and are generally at work. 20 per cent, perhaps, are gamblers and idlers voluntarily; 99 per cent of the women are prostitutes.
3. What are their social habits? The men never associate or mingle with any one outside of themselves. Judging from the few married ones among them it appears they are a little too social for Americans, and would say their social habits are bad, compared to our standard.
4. What are their sanitary habits? In their person it appears they are cleanly, but their habitations are generally surrounded with slops and garbage. All would indicate bad sanitary habits.
5. How many of them are married? Say 5 per cent that have their families here.
6. How many of them are employed? 80 per cent—560.
7. How many of them are domestic servants? 300.
8. What wages are paid to domestic servants per week? $3 to $5. Per month? $12 to $20 with board.
9. How many of them are cooks? 250 to 300.
10. What wages are paid to them per week? $3 to $5. Per month? $12 to $25 with board.
11. How many are laundrymen? 80, on their own account.
13. How many Chinese laundries are in your county? 27.
14. How many Chinese do they employ in your county? 80.
15. How many Chinese cultivate the soil in your county? 100.
16. What wages are paid to them per month with board? Usually own account.
17. How many Chinese miners are in your county? 100.
23. How much do they expend for rent collectively per month? $1,400.
24. How much do they expend for food collectively per month? $4,800.
25. What percentage of the food are home products? 50 per cent.
26. What percentage of the food are imported from foreign countries? 50 per cent.
27. How much do they expend for clothing each year? About $16,000.
28. What percentage of the clothing is of American manufacture? 66 per cent.
29. What percentage of the clothing is imported? 33 per cent.
30. How much of their yearly earnings are sent out of the country? $20,000.
31. What percentage to the amount of earnings? 18 per cent.
32. To what extent does their employment come in competition with the white industrial classes? Their laundries cut off work from 80 white women. They are employed as cooks and domestic servants, which cuts off work from at least 300 white men. These 380 whites would come into the county if these competitions did not exist.

Form No. 8.

Relating to Inmates of Jails and Other Reformatory Institutions.

1. How many inmates are in your county jail and other reformatory institutions in your county? Males, 14; Chinese, 1.
2. What are their ages? 17 to 40.
3. What are their nationalities? 75 per cent of Irish, 5 per cent of German, 5 per cent of Spanish, 15 per cent of native sons and Americans.
4. What are their conditions and sanitary habits? Jail crowded, needs ventilation and drainage.
7. To what extent does their employment come in competition with the labor of mechanics, artisans, and all other white laborers outside of reformatory institutions? No extent.

STATE BUREAU OF LABOR STATISTICS.

Statistical Statement made by G. W. Lewis, Assessor of Sonoma County.

FORM NO. 1.

Relating to Agriculture.

1. How many acres of land (exclusive of town lots) does your county contain? 850,000.
2. How many acres of land (exclusive of town lots) are under cultivation? 250,000.
2½. How many acres of land are used for grazing? 300,000.
3. How many acres of land (exclusive of town lots) are unfit for cultivation? 100,000.
4. How many acres of land (exclusive of town lots) are timber land? 100,000.
5. How many acres of land (exclusive of town lots) are open for preëmption? 100,000.
6. What is the maximum price per acre (exclusive of town lots)? $100.
7. What is the minimum price per acre (exclusive of town lots)? $5.
8. What is the average price per acre (exclusive of town lots)? $30.
9. How many ranches are in your county? 4,500.
10. How many ranch owners? 4,500.
11. How many have from three to ten acres? 850.
12. How many have from ten to twenty-five acres? 500.
13. How many have from twenty-five to fifty acres? 800.
14. How many have from fifty to one hundred acres? 1,200.
15. How many have from one hundred to two hundred and fifty acres? 600.
16. How many have from two hundred and fifty to five hundred acres? 225.
17. How many have from five hundred to one thousand acres? 150.
18. How many have from one thousand to two thousand five hundred acres? 100.
19. How many have from two thousand five hundred to five thousand acres? 50.
20. How many have five thousand acres and over? 25.
21. How many ranches are worked by owners? Most of them.
22. How many ranches are worked in shares between owner and renter? Very few.
23. How many ranches are worked in shares between owners and laborers? None.
24. How many ranches are rented? About 500.
25. What is the maximum rent per acre? $10.
26. What is the minimum rent per acre? $3.
27. What is the average rent per acre? $5.
28. How many buildings of all kinds (exclusive of city or town buildings) does your county contain? About 10,000.
29. What is their value? About $3,000,000.
30. How many miles of fences are in your county? About 100,000.
31. What is their cost per mile? $250.
32. What is the value of all the agricultural implements in your county? $200,000.
34. What is their value? About $100,000.
36. What percentage of ranch cultivators in your county (or township) use labor-saving machines? 80 per cent.

Relating to Farm Hands and Road Laborers.

37. How many laborers (Chinese excluded) are employed in agriculture in your county? About 1,500.
38. What are their ages? From 15 to 50.
39. How many under fifteen years of age? Very few, if any.
40. How many of the laborers are females? None.
42. What are the maximum wages paid (including board) per month? $30.
43. What are the minimum wages paid (including board) per month? $20.
44. What are the average wages paid (including board) per month? $25.
45. What industry of agriculture pays the maximum? All branches.
46. What industry of agriculture pays the minimum? Pay the average.
47. How many months in the year are laborers generally employed? All the year.
48. When unemployed in agriculture what industry do they pursue to gain a livelihood? They work on roads, streets, dig ditches, or haul lumber or other material.
49. What are the maximum hours of labor per diem? 14.
50. What are the minimum hours of labor per diem? 10.
51. What are the average hours of labor per diem? 12.
52. Are those working over the regular hours constituting a day's work, paid extra? No.
54. If from sickness laborers must abstain from work, are any deductions made from his wages? Yes, if hired by the day; if hired by the month, no deduction is made.
55. How many road laborers are in your county? All road work is done by farm laborers when unemployed in agriculture.
56. What is the wages paid to them? $2.
57. What is the laborer's condition in general? Morally, good; physically, good; mentally, good.
58. How many laborers (exclusive of Chinese) are in your county unemployed? None.
65. What are the causes of their idleness? (Please state everything you know about it.) The cause of idleness with any laborer is dissolute habits. No man need to be idle in Sonoma County who is sober, industrious, and willing to work.
70. How are the sanitary conditions of the lands in your county? Very good.

FORM

Relating to Employés in Mechanical and

Number of Questions.	Description of Items.
7	How many bakers in the whole county
8	How many brewers in the whole county
9	How many blacksmiths in the whole county
12	How many bookbinders in the whole county
13	How many brick makers in the whole county
14	How many broom makers in the whole county
20	How many canneries (fruit, fish, etc.,) in the whole county? Each cannery employs about 50 persons
21	How many carpenters and joiners in the whole county
23	How many carriage and wagon makers in the whole county
27	How many confectioners in the whole county
29	How many coopers in the whole county
32	How many distilleries in the whole county. Each employing from two to five men
33	How many employês in dairies in the whole county
35	How many glovemakers in the whole county
37	How many gunsmiths in the whole county
43	How many machinists in the whole county
44	How many marble cutters in the whole county
46	How many millers in the whole county
51	How many plumbers in the whole county
54	How many saddlers and harness makers in the whole county
58	How many shingle makers in the whole county
59	How many shoemakers in the whole county
60	How many soda works employés in the whole county
62	How many tailors in the whole county
63	How many tanners in the whole county
64	How many tinsmiths in the whole county
65	How many upholsterers in the whole county
66	How many wheelwrights in the whole county
67	How many wine manufacturers in the whole county
69	How many woolen mills employés in the whole county
70	How many of the aforementioned professions are unemployed? None

No. 2.

Manufacturing Industries (*Chinese Excluded*).

Total Number	Hours Constituting a Day's Work.			Sex.		Wages Paid to Males.				Wages Paid to Females.			
	Maximum	Minimum	Average	Males	Females	Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board
15	10	10	10	------	------	$3 50	$2 50	$3 00	*	------	------	------	----
4	10	10	10	------	------	3 50	2 50	3 00	*	------	------	------	----
30	10	10	10	------	------	3 50	2 50	3 00	†	------	------	------	----
1	10	10	10	------	------	4 00	4 00	4 00	†	------	------	------	----
1	10	10	10	------	------	2 00	2 00	2 00	†	------	------	------	----
1	10	10	10	------	------	2 50	2 50	2 50	†	------	------	------	----
2	10	10	10	------	------	1 50	1 50	1 50	------	$0 75	$0 75	$0 75	†
150	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
30	10	10	10	------	------	4 00	2 50	3 00	†	------	------	------	----
5	10	10	10	------	------	4 00	4 00	4 00	*	------	------	------	----
5	10	10	10	------	------	4 00	2 00	3 00	†	------	------	------	----
15	10	10	10	------	------	2 00	2 00	2 00	†	------	------	------	----
100	12	12	12	------	------	1 00	1 00	1 00	*	------	------	------	----
2	10	10	10	------	------	2 50	2 50	2 50	†	------	------	------	----
6	10	10	10	------	------	2 50	2 50	2 50	†	------	------	------	----
10	10	10	10	------	------	4 00	2 00	3 00	†	------	------	------	----
10	10	10	10	------	------	3 00	3 00	3 00	†	------	------	------	----
20	10	10	10	------	------	2 50	2 50	2 50	†	------	------	------	----
15	10	10	10	------	------	3 00	3 00	3 00	†	------	------	------	----
30	10	10	10	------	------	2 50	2 50	2 50	†	------	------	------	----
20	12	12	12	------	------	2 50	2 50	2 50	†	------	------	------	----
50	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
10	10	10	10	------	------	3 00	3 00	3 00	†	------	------	------	----
30	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
10	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
10	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
10	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
20	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
35	10	10	10	------	------	3 00	2 00	2 50	†	------	------	------	----
80	10	10	10	------	------	3 00	2 00	2 50	†	75	75	75	†
------	------	------	------	------	------	------	------	------	------	------	------	------	----

* With.
† Without.

Form No. 3.

Relating to Mines and Miners (*Chinese Excluded*).

19. How many quicksilver mines in your county now worked? Three.
Number of miners, 150.
Hours constituting a day's work—Maximum, 12; minimum, 12; average, 12.
Number of months employed in the year, 12.
Wages per day—Maximum, $3; minimum, $2; average, $2 50; without board.

FORM

Relating to Transportation on Land

Number of Questions	Description of Items.
1	How many miles of steam railroads in operation are in your county
2	How many employés of all kinds on above are in your county
5	How many miles of street railroads (horse-power) are in your county
6	How many men are engaged thereon in your county
11	How many stage drivers in your county
13	How many draymen hauling, etc., in your connty
14	How many agents, railroad, stage, express, and steamboats in your county
15	How many men are engaged in express companies in your county

FORM

Relating to Clerical and all other Skilled and Unskilled

Number of Questions	Description of Items.
1	How many auctioneers are employed in your county
4	How many barbers are employed in your county
5	How many bookkeepers in all departments in your county
6	How many bricklayers in your county
7	How many clerks are employed in banking institutions in your county
8	How many clerks are employed in insurance offices in your county
10	How many clerks employed in general merchandising in your county
11	How many clerks are employed in county governments in your county
12	How many cooks are employed in your county
13	How many dentists are employed in your county
15	How many draymen are employed in your county
16	How many dress and cloak makers in your county
18	How many engineers (civil) in your county
19	How many engineers (stationary engines) in your county
21	How many florists and gardeners in your county
24	How many journalistic editors in your county
25	How many journalistic reporters in your county
26	How many hod carriers in your county
27	How many hostlers in your county
30	How many lumbermen in your county
31	How many milliners in your county
32	How many painters (house) in your county
33	How many fresco painters are employed in your county
34	How many plasterers are employed in your county
35	How many printers are employed in your county
36	How many photographers are employed in your county
37	How many school teachers are employed in your county
40	How many telegraph operators are employed in your county
42	How many waiters (restaurant, hotel, etc.,) are employed in your county
43	How many watchmakers are employed in your county
47	How many woodcutters are employed in your county
49	How many foregoing mentioned professions are unemployed? Males, none; females, none

No. 4.

and Water (Chinese Excluded).

Miles of Roads	Number of Men	Average Hours per Day	Average Number of Months Engaged per Annum	Wages Paid. Maximum	Minimum	Average	With or Without Board
118	200	10	12	$3 00	$2 00	$2 50	Without
2							
	1	12	12	2 00	2 00	2 00	Without
	5	12	12	2 50	2 50	2 50	With
	20	12	12	2 50	2 50	2 50	Without
	25	10	12	4 00	2 50	3 00	Without
	25	12	12	4 00	2 50	3 00	Without

No. 5.

Labor not before Enumerated (Chinese Excluded).

Total Number	Sex. Males	Females	Hours Constituting a Day's Work. Maximum	Minimum	Average	Average No. Months Engaged per Annum	Wages Paid to Males. Maximum	Minimum	Average	With or Without Board	Wages Paid to Females. Maximum	Minimum	Average	With or Without Board
5	5		8	8	8	12	$5 00	$5 00	$5 00	*				
50	50		12	12	12	12	2 50	2 50	2 50	*				
15	15		8	8	8	12	3 00	3 00	3 00	*				
10	10		10	8	8	10	3 00	3 00	3 00	*				
10	10		6	6	6	12	3 00	3 00	3 00	*				
5	5		8	8	8	12	3 00	3 00	3 00	*				
100	100		12	12	12	12	2 50	2 50	2 50	*				
5	5		8	8	8	12	4 00	4 00	4 00	*				
30	30		12	12	12	12	1 50	1 50	1 50	†				
5	5		8	8	8	12	4 00	4 00	4 00	*				
20	20		12	12	12	12	2 50	2 50	2 50	*				
20		20	10	10	10	12					$2 50	$2 50	$2 50	*
2	2		8	8	8	12	10 00	10 00	10 00	*				
25	25		10	10	10	12	4 00	4 00	4 00	*				
4	4		12	12	12	12	3 00	3 00	3 00	*				
12	12		8	8	8	12	5 00	5 00	5 00	*				
20	20		8	8	8	12	5 00	5 00	5 00	*				
10	10		10	10	10	10	2 00	2 00	2 00	*				
50	50		12	12	12	12	1 00	1 00	1 00	†				
500	500		12	12	12	8	3 00	2 00	2 50	*				
10		10	10	10	10	12					3 00	2 00	2 50	*
50	50		10	10	10	10	3 00	2 00	2 50	*				
1	1						5 00	5 00	5 00	*				
10	10		10	10	10	10	4 00	4 00	4 00	*				
50	40	10	8	8	8	12	4 00	2 00	3 00	*	3 00	2 00	2 50	*
6	6		8	8	8	12	5 00	5 00	5 00	*				
140	40	100	8	4	6	10	5 00	2 00	3 00	*	3 50	2 00	3 00	*
10	10		8	8	8	12	3 00	3 00	3 00	*				
50	50		10	10	10	12	1 00	1 00	1 00	†				
10	10		8	8	8	12	3 00	3 00	3 00	*				
150	150		12	12	12	12	2 50	2 50	2 50	*				

* Without. † With.

Form No. 6.

Miscellaneous.

1. What is the total value of all lands and town lots in your county? $12,500,000.
2. What is the total value of all the buildings in the towns of your county? $3,500,000.
3. What is the total value of all the machinery used for mechanical and manufacturing purposes? $50,000.
4. What is the total value of all materials, including grain for flour, used in manufactures in your county? $1,000,000.
5. To what extent does the apprenticeship system prevail in the various skilled industries in your county (or township)? There is none.
6. Are any trades unions in your county? No.
12. What is the cost of rent of dwellings generally occupied by the wage workers? $10 per month.
14. What is the cost of food or board per month? $20 per month.
15. What is the cost of fuel? Wood, $5 per cord.
16. What is the cost of water for household purposes per month? $1 50.
17. What is the cost of water for irrigation purposes? $1.
18. How many poor people live in your county? Males, 10; females, 15.
19. Their ages? From 40 to 80.
20. The cause? Age, disease, large family of small children with only the mother left for support.

Nationality? Mixed.

22. What are their conditions? Sanitary, fair; morally, fair.
24. How many corporations (local) are in your county? 17.
25. Name them? Santa Rosa Water Company, Santa Rosa Woolen Mill, Santa Rosa Gas Company, Santa Rosa Street Railroad Company, Santa Rosa Fruit Preserving Company, Santa Rosa Flour Mill, Santa Rosa Bank, Santa Rosa Savings Bank, Santa Rosa Winery, Santa Rosa Planing Mill, Petaluma Savings Bank, Petaluma Bank of Sonoma County, Sonoma Valley Bank, Healdsburg Bank, Healdsburg Farmers' and Mechanics' Bank, Cloverdale Bank, Petaluma Water Company.
27. Name cash capital invested in them? $1,500,000.

Form No. 7.

Relating to Chinese (Exclusively).

1. How many Chinese are in your county? Males, 1,000; females, 20.
2. What are their conditions? Do not know.
3. What are their social habits? Bad.
4. What are their sanitary habits? Bad; filthy.
5. How many of them are married? None.
6. How many of them are employed? 80 per cent.
7. How many of them are domestic servants? 50 per cent.
8. What wages are paid to domestic servants per week? $5; per month, $20 with board.
9. How many of them are cooks? All domestic servants.
11. How many are laundrymen? 25 per cent.
13. How many Chinese laundries are in your county? 50.
14. How many Chinese do they employ in your county? 250.
15. How many Chinese cultivate the soil in your county? 250.
16. What wages are paid them per month with board? Without board, $26.
23. How much do they expend for rent either per head or collectively per month? Very little.
24. How much do they expend for food per head or collectively per month? Very little.
25. What percentage of the food are home products? 25 per cent.
26. What percentage of the food are imported from foreign countries? 75 per cent.
28. What percentage of the clothing is of American manufacture? 25 per cent.
29. What percentage of the clothing is imported? 75 per cent.
30. How much of their yearly earnings are sent out of the country? 75 per cent.
31. What percentage to the amount of earnings? 75 per cent.
32. To what extent does their employment come in competition with the white industrial classes? The same as 75 is to 100.

Form No. 8.

Relating to Inmates of Jails and other Reformatory Institutions.

1. How many inmates are in your county jail and other reformatory institutions in your county? Males, 40; females, 4; Chinese, 15.
2. What are their ages? Males, 18 to 80; females, 60 to 80; Chinese, 15 to 40.
3. What are their nationalities? Mixed.
4. What are their conditions and sanitary habits? Good, owing to the discipline enforced by the authorities. There are no females in the jail. Those mentioned above are inmates of the county poor-farm. Also, of the 40 males there are 30 who, on account of age, are inmates of the poor-farm. All the Chinese are inmates of the county jail.
5. How many of the inmates are employed? 10.
6. What does their employment consist of? Males, working streets in chaingang; Chinese, working in chaingang.
7. To what extent does their employment come in competition with the labor of mechanics, artisans, and all other white laborers outside of reformatory institutions? Their labor does not interfere with the white laborer.

Statistical Statement made by T. V. Mathews, Assessor of Santa Cruz County.

FORM NO. 1.

Relating to Agriculture.

1. How many acres of land (exclusive of town lots) does your county contain? 252,765.
2. How many acres of land (exclusive of town lots) are under cultivation? 30,168.
3. How many acres of land (exclusive of town lots) are unfit for cultivation? 95,441.
4. How many acres of land (exclusive of town lots) are timber land? 125,609.
5. How many acres of land (exclusive of town lots) are open for preëmption? 3,000.
6. What is the maximum price per acre (exclusive of town lots)? $250.
7. What is the minimum price per acre (exclusive of town lots)? $1 25.
8. What is the average price per acre (exclusive of town lots)? $16.
9. How many ranches are in your county? 1,520.
10. How many ranch owners? Estimated 1,520.
11. How many have from three to ten acres? 293.
12. How many have from ten to twenty-five acres? 276.
13. How many have from twenty-five to fifty acres? 259.
14. How many have from fifty to one hundred acres? 420.
15. How many have from one hundred to two hundred and fifty acres? 147.
16. How many have from two hundred and fifty to five hundred acres? 65.
17. How many have from five hundred to one thousand acres? 41.
18. How many have from one thousand to two thousand five hundred acres? 5.
19. How many have from two thousand five hundred to five thousand acres? 7.
20. How many have five thousand acres and over? 7.
21. How many ranches are worked by owners? Estimated, 1,344.
24. How many ranches are rented? Estimated, 176.
25. What is the maximum rent per acre? $8.
26. What is the minimum rent per acre? $3.
27. What is the average rent per acre? $5.
28. How many buildings of all kinds (exclusive of city or town buildings) does your county contain? Estimated at 1,300.
29. What is their value? $474,505.
30. How many miles of fences are in your county (or township)? Estimated at 800.
31. What is their cost per mile? $320.
32. What is the value of all the agricultural implements in your county? $10,655.
33. How many labor-saving agricultural implements are in your county? 36.
34. What is their value? $4,320.
35. What is their combined horse (or man) power? 216.
36. What percentage of ranch cultivators in your county use labor-saving machines? 2½.

Relating to Farm Hands and Road Laborers.

37. How many laborers (Chinese excluded) are employed in agriculture in your county? Estimated at 300.
38. What are their ages? From 20 to 55.
39. How many are under fifteen years of age? None.
40. How many of the laborers are females? None.
42. What are the maximum wages paid (including board) per month? $40.
43. What are the minimum wages paid (including board) per month? $15.
44. What are the average wages paid (including board) per month? $30.
47. How many months in the year are laborers generally employed? Casual laborers, 6 months.
48. When unemployed in agriculture what industry do they pursue to gain a livelihood? They leave the county, and how they afterwards maintain themselves is not known.
49. What are the maximum hours of labor per diem? 12.
50. What are the minimum hours of labor per diem? 8.
51. What are the average hours of labor per diem? 10.
52. Are those working over the regular hours constituting a day's work, paid extra? No.
54. If from sickness laborers must abstain from work, are any deductions made from his wages? Yes, he is paid only for the days that he performs labor.
58. How many laborers (exclusive of Chinese) are in your county unemployed?
65. What are the causes of their idleness? (Please state everything you know about it.) As a proposition there are no road laborers in the above sense. Roads are worked by the owners of land adjoining or by their substitutes.
66. What steps can be taken, or what is necessary, to obtain employment for all in your county? All who seek labor can obtain it without any difficulty.
67. How do they obtain sustenance and clothing? By purchase from their wages.
68. In what condition are the roads of your county (railroads excluded)? Fair.
69. Can you suggest anything that will ameliorate the condition of the laborers and accrue to their benefit? The practice of industry and the observance of sobriety will much benefit them.
70. How are the sanitary conditions of the lands in your county? Could not be better.

FORM

Relating to Employés in Mechanical and

Number of Questions	Description of Items.
1	How many asphaltum workers are employed in the whole county
7	How many bakers in the whole county
8	How many brewers in the whole county
9	How many blacksmiths in the whole county
10	How many boilermakers in the whole county
11	How many brass molders in the whole county
13	How many brick makers in the whole county
18	How many cabinet makers in the whole county
20	How many canneries (fish, fruit, etc.) employés in the whole county
21	How many carpenters and joiners in the whole county
23	How many carriage and wagon makers in the whole county
26	How many cigar makers in the whole county
27	How many confectioners in the whole county
29	How many coopers in the whole county
30	How many coppersmiths in the whole county
33	How many employés in butter and cheese dairies in the whole county
36	How many gluemakers in the whole county
37	How many gunsmiths in the whole county
39	How many iron molders in the whole county
41	How many locksmiths in the whole county
42	How many employés in limekilns in the whole county
43	How many machinists in the whole county
44	How many marble cutters in the whole county
46	How many millers in the whole county
47	How many pattern makers in the whole county
48	How many employés in paper mills in the whole county
50	How many employés in powder mills in the whole county
51	How many plumbers in the whole county
54	How many saddlers and harness makers in the whole county
57	How many stone masons in the whole county*
58	How many shingle makers in the whole county
59	How many shoemakers in the whole county
60	How many soda works employés in the whole county
61	How many stonecutters in the whole county
62	How many tailors in the whole county
63	How many tanners in the whole county
64	How many tinsmiths in the whole county
65	How many upholsterers in the whole county

* Sash, door, and blind makers, there are none.

No. 2.

Manufacturing Industries (Chinese Excluded).

Total Number	Hours Constituting a Day's Work. Maximum	Hours Constituting a Day's Work. Minimum	Hours Constituting a Day's Work. Average	Sex. Male	Sex. Female	Wages Paid to Males. Maximum	Wages Paid to Males. Minimum	Wages Paid to Males. Average	Wages Paid to Males. With or Without Board	Wages Paid to Females. Maximum	Wages Paid to Females. Minimum	Wages Paid to Females. Average	Wages Paid to Females. With or Without Board
16	10	10	10	16	----	D $5 00	D $3 50	D $4 00	----	----	----	----	----
8	15	10	12	8	----	60 00	40 00	50 00	†	----	----	----	----
14	12	10	11	14	----	45 00	25 00	35 00	†	----	----	----	----
53	10	10	10	53	----	D 3 00	D 2 75	D 1 50	*	----	----	----	----
3	10	10	10	3	----	D 5 00	D 4 00	D 4 00	*	----	----	----	----
2	10	10	10	2	----	D 3 50	D 5 00	D 3 00	*	----	----	----	----
10	10	10	10	10	----	60 00	50 00	40 00	†	----	----	----	----
4	10	10	10	4	----	D 4 00	D 2 00	D 3 00	*	----	----	----	----
25	10	10	10	7	18	D 3 00	D 1 00	D 2 00	*	D $1 00	D $0 75	D $0 87½	*
45	10	10	10	45	----	D 4 00	D 2 00	D 3 00	*	----	----	----	----
14	10	10	10	14	----	D 4 00	D 2 00	D 3 00	*	----	----	----	----
2	10	10	10	2	----	75 00	50 00	60 00	*	----	----	----	----
4	10	10	10	4	----	D 3 00	D 2 00	D 2 50	*	----	----	----	----
25	12	8	10	25	----	60 00	60 00	60 00	†	----	----	----	----
5	10	10	10	5	----	D 3 50	D 2 50	D 3 00	*	----	----	----	----
80	12	12	12	80	----	60 00	20 00	28 00	†	----	----	----	----
4	10	10	10	4	----	50 00	40 00	45 00	*	----	----	----	----
2	10	10	10	2	----	D 3 50	D 2 50	D 3 00	*	----	----	----	----
4	10	10	10	4	----	D 3 50	D 2 50	D 3 00	*	----	----	----	----
4	10	10	10	4	----	D 3 00	D 2 00	D 2 50	*	----	----	----	----
110	12	8	10	110	----	50 00	40 00	45 00	†	----	----	----	----
6	10	10	10	6	----	D 4 00	D 3 00	D 3 00	*	----	----	----	----
3	10	10	10	3	----	D 3 00	D 1 50	D 2 50	*	----	----	----	----
5	10	10	10	5	----	100 00	50 00	60 00	*	----	----	----	----
2	10	10	10	2	----	D 3 50	D 3 00	D 3 25	*	----	----	----	----
90	10	10	10	90	----	70 00	50 00	60 00	*	----	----	----	----
80	10	10	10	80	----	D 3 00	D 1 75	D 2 00	*	----	----	----	----
6	10	10	10	6	----	D 3 50	D 2 50	D 3 00	*	----	----	----	----
10	10	10	10	10	----	75 00	60 00	50 00	*	----	----	----	----
10	10	10	10	10	----	D 5 00	D 3 00	D 2 50	*	----	----	----	----
36	10	10	10	36	----	60 00	35 00	45 00	†	----	----	----	----
30	10	10	10	30	----	D 4 00	D 2 00	D 3 00	*	----	----	----	----
4	10	10	10	4	----	50 00	30 00	35 00	*	----	----	----	----
4	10	10	10	4	----	D 5 00	D 3 00	D 3 50	*	----	----	----	----
10	10	10	10	10	----	D 3 00	D 1 50	D 2 25	*	----	----	----	----
94	10	10	10	94	----	50 00	30 00	40 00	†	----	----	----	----
16	10	10	10	16	----	D 3 50	D 2 50	D 3 00	*	----	----	----	----
6	10	10	10	6	----	D 4 00	D 2 50	D 3 00	*	----	----	----	----

D Means daily wages.
* Without.
† With.

FORM

Relating to Mines and

Number of Questions	Description of Items.
1	How many asphaltum mines are in your county
2	How many asphaltum miners are in your county
5	How many gold placer mines are in your county
6	How many gold placer miners are in your county
25	How many limestone quarries are in your county
26	How many limestone miners are in your county

FORM

Relating to Transportation on Land

Number of Questions	Description of Items.
1	How many miles of steam railroads in operation are in your county
2	How many employés of all kinds on above are in your county
5	How many miles of street railroads (horse-power) are in your county
8	How many drivers are engaged thereon in your county (driving conductors)
11	How many stage drivers in your county
12	How many teamsters hauling, etc., in your county
13	How many draymen hauling, etc., in your county
14	How many agents, railroad, stage, express, and steamboat in your county
15	How many men are engaged in express companies in your county

No. 3.

Miners (*Chinese Excluded*).

Number of Mines	Number of Miners	Hours Constituting a Day's Work.			Number of Months Employed in the Year	Wages per Day.			
		Maximum	Minimum	Average		Maximum	Minimum	Average	With or Without Board
1	6	10	10	10	3	D$3 50	D$2 00	D$2 75	Without
1	5	10	10	10	4	D7 00	D6 00	D5 00	Without
6	32	11	11	11	9	63 00	53 00	55 00	With

D Means daily wages.

No. 4.

and Water (*Chinese Excluded*).

Miles of Roads	Number of Men	Average Hours per day	Average Number of Months Engaged per Annum	Wages Paid.			
				Maximum	Minimum	Average	With or Without Board
41	53	12	12	$150 00	$46 00	$55 00	Without
2½	5	12	12	60 00	50 00	55 00	Without
	4	7	12	60 00	50 00	55 00	Without
	240	10	9	75 00	35 00	50 00	Without
	25	10	12	50 00	40 00	45 00	Without
	12	8	12	80 00	35 00	58 00	Without
	10	14	12	90 00	60 00	70 00	Without

FORM

Relating to Clerical and all other Skilled and Unskilled

Number of Questions	Description of Items.	Total Number	Sex.	
			Males	Females
1	How many auctioneers are employed in your county	2	2	----
4	How many barbers are employed in your county	14	14	----
5	How many bookkeepers in all departments in your county	6	6	----
6	How many bricklayers in your county	10	10	----
7	How many clerks are employed in banking institutions in your county	4	4	----
10	How many clerks employed in general merchandising in your county	108	98	10
11	How many clerks are employed in county and town governments in your county	9	9	----
12	How many cooks are employed in your county (or town)	80	70	10
13	How many dentists are employed in your county (or town)	7	7	----
15	How many draymen are employed in your county (or town)	25	25	----
16	How many dress and cloak makers in your county (or town)	90	-----	90
17	How many engravers in your county (or town)	4	4	----
19	How many engineers (stationary engines) in your county (or town)	52	52	----
21	How many florists and gardeners in your county (or town)	6	6	----
22	How many fishermen in your county (or town)	35	35	----
23	How many glaziers in your county (or town)	5	5	----
24	How many journalistic editors in your county (or town)	5	5	----
26	How many hod carriers in your county (or town)	10	10	----
27	How many hostlers in your counyt (or town)	46	46	----
30	How many lumbermen in your county (or town)	610	610	----
31	How many milliners in your county (or town)	16	-----	16
32	How many painters (house) in your county (or town)	15	15	----
33	How many fresco painters are employed in your county	2	2	----
34	How many plasterers are employed in your county	8	8	----
35	How many printers are employed in your county	21	21	----
36	How many photographers are employed in your county	3	2	1
37	How many school teachers are employed in your county	76	14	62
38	How many seamstresses are employed in your county	11	-----	11
39	How many servants (domestic) are employed in your county	65	16	51
40	How many telegraph operators are employed in your county	4	2	2
41	How many telegraph messenger boys are employed in your county	2	2	----
42	How many waiters (restaurant, hotel, etc.,) are employed in your county	79	26	53
43	How many watchmakers are employed in your county	8	8	----
45	How many well-borers (oil) are employed in your county	12	12	----
46	How many wood carvers and turners are employed in your county	3	3	----
47	How many woodcutters are employed in your county	260	260	----
49	Butchers and their employés	37	37	----

No. 5.

Labor not before Enumerated (Chinese Excluded).

Hours Constituting a Day's Work.			Average No. Months Engaged per Annum	Wages Paid to Males.				Wages Paid to Females.			
Maximum	Minimum	Average		Maximum	Minimum	Average	With or Without Board	Maximum	Minimum	Average	With or Without Board
*	*	*	----	*	*	*	----	----	----	----	----
14	12	11	12	$70 00	$50 00	$60 00	†	----	----	----	----
11	10	10½	----	100 00	50 00	65 00	†	----	----	----	----
10	10	10	10	D 4 00	D 4 00	D 4 00	†	----	----	----	----
7	6	6½	12	150 00	100 00	125 00	†	----	----	----	----
12	10	11	12	75 00	12 00	43 00	†	$35 00	$20 00	$27 00	†
14	8	10	6	100 00	40 00	70 00	†	----	----	----	----
14	11	13	9	80 00	20 00	35 00	‡	25 00	20 00	22 00	‡
9	7	8	12	75 00	50 00	65 00	†	----	----	----	----
----	7	----	12	50 00	40 00	45 00	†	----	----	----	----
12	9	10	10	----	----	----	----	D 1 50	D 50	D 1 00	----
10	10	10	1	D 4 00	D 3 00	D 3 50	----	----	----	----	----
12	10	11	8	75 00	30 00	50 00	‡	----	----	----	----
10	10	10	8	D 3 00	D 2 50	D 2 75	†	----	----	----	----
18	8	13	10	120 00	40 00	60 00	†	----	----	----	----
10	10	10	2	D 3 50	D 4 00	D 3 75	†	----	----	----	----
8	8	8	12	85 00	85 00	85 00	†	----	----	----	----
10	10	10	8	D 2 50	D 1 50	D 2 00	----	----	----	----	----
16	8	12	6	60 00	50 00	40 00	‡	----	----	----	----
10	10	10	9	65 00	45 00	55 00	‡	----	----	----	----
12	10	11	10	----	----	----	----	D 1 50	D 50	D 1 00	†
10	10	10	6	D 3 00	D 2 00	D 2 50	†	----	----	----	----
10	10	10	3	D 4 00	D 3 00	D 3 50	†	----	----	----	----
10	10	10	10	D 4 00	D 3 50	D 3 00	†	----	----	----	----
10	10	10	12	D 3 00	D 50	D 2 00	†	----	----	----	----
10	9	8	12	65 00	25 00	45 00	†	30 00	30 00	30 00	†
6	6	6	8½	130 00	60 00	77 00	†	80 00	40 00	54 00	†
10	10	10	8	----	----	----	----	D 1 50	D 75	D 1 25	†
12	12	12	9	25 00	10 00	15 00	‡	25 00	10 00	15 00	‡
12	4	11	12	75 00	45 00	60 00	†	50 00	25 00	38 00	†
12	4	11	12	15 00	10 00	12 00	†	----	----	----	----
13	12	12½	7	30 00	15 00	20 00	‡	20 00	15 00	17 00	‡
15	10	12	12	100 00	75 00	85 00	†	----	----	----	----
10	10	10	12	D 5 00	D 3 00	D 3 50	‡	----	----	----	----
10	10	10	12	D 3 50	D 2 50	D 3 00	†	----	----	----	----
10	10	10	9	D 2 50	D 2 00	D 2 25	†	----	----	----	----
15	12	14	12	60 00	50 00	55 00	†	----	----	----	----

* Nominal.
† Without.
D Means daily wages.
‡ With.

Form No. 6.

Miscellaneous.

1. What is the total value of all lands and town lots in your county (or township)? $4,294,370.
2. What is the total value of all the buildings in the towns of your county (or township)? $1,271,245.
3. What is the total value of all the machineries used for mechanical and manufacturing purposes? $63,275.
5. To what extent does the apprenticeship system prevail in the various skilled industries in your county (or township)? Not at all.
6. Are any trades unions in your county? No.
9. How are the sanitary conditions of the workshops of mechanics and manufacturers? Good.
10. How are the sanitary conditions of the dwellings of the wage-workers? Good.
14. What is the cost of food or board per month? $18 to $20.
15. What is the cost of fuel? Wood, $6 per cord.
16. What is the cost of water for household purposes per month? $1 50.
17. What is the cost of water for irrigation purposes? For lawns, 1 cent per square yard; gardens, $1 per acre.
24. How many corporations (local) in your county? 9.
25. Name them? Santa Cruz County Bank, capital stock, $100,000; Santa Cruz Bank of Savings and Loan, capital stock, $100,000; Bank of Watsonville, capital stock, $200,000; Watsonville Mill and Lumber Company, capital stock, $160,000; Pacific Avenue Street Railroad Company, capital stock, $100,000; Santa Cruz Water Company, capital stock, $100,000; Santa Cruz Gas Company, capital stock, $36,000; Santa Cruz Fair Building Association, capital stock, $10,000; Santa Cruz Horticultural Association, capital stock, $5,000.
26. Name capital stock of each? See above.
27. Name cash capital invested in them? $527,000, aggregate.
28. Total amount of hands employed in each? 322, aggregate.

Form No. 7.

Relating to Chinese (Exclusively).

1. How many Chinese are in your county (or township)? Males, 240; females, 6.
5. How many of them are married? 6.
6. How many of them are employed? 206.
7. How many of them are domestic servants? 45.
8. What wages are paid to domestic servants per week? $5; per month, $20, with board.
9. How many of them are cooks? 30.
10. What wages are paid to them per week? $5; per month, $20, with board.
11. How many are laundrymen? 64.
12. What wages do they earn per week? $4; per month, $16, with board.
13. How many Chinese laundries are in your county (or township)? 8.
14. How many Chinese do they employ in your county (or township)? See No. 11.
15. How many Chinese cultivate the soil in your county (or township)? 67.
16. What wages are paid them per month with board? $20.

Form No. 8.

Relating to Inmates of Jails and other Reformatory Institutions.

1. How many inmates are in your county jail and other reformatory institutions in your county? Males, 4; Chinese, 1.
2. What are their ages? Males, 28 to 35; Chinese, 24.
3. What are their nationalities? Swiss, 1; Irish, 2; Chinese, 1.
4. What are their conditions and sanitary habits? Good.
5. How many of the inmates are employed? None.

EMPLOYERS' RETURNS—ANSWERS TO FORM A.

Name of Firm	Town	Articles Manufactured	Capital Invested	Value of Material Used in Twelve Months	Paid for Labor Last Twelve Months	Net Profit	Greatest Number of Hands Employed at one Time During Last Year	Average Number of White Males Employed over Sixteen Years of Age	Average Number of White Females Employed over Sixteen Years of Age	Average Number of Boys and Girls Employed	Number of Months Run on Full Time	Half Time	Idle	Average Number of Chinese Hands Employed in Last Twelve Months	Have Wages been Advanced	What Per Cent	Have Wages been Reduced	What Per Cent	Average Day Wages for Skilled Work: Men	Average Day Wages for Skilled Work: Women	Average Day Wages for Ordinary Labor: Men	Women	Boys	Girls	How Wages are Paid
M[illegible]	Oakland	Har[illegible]	$47,[illegible]		[illegible]	$1,9[illegible]7 96	None	51	18	[illegible]	25	12			None	No.		No		[illegible] 00		$1 75		$0 50	$0 10	Monthly
[illegible]	San Jo[illegible]	[illegible]	[illegible],000 to 6,000 00	[illegible]	6,000 00		12	4		5	8	1				No		No		2 50		2 00		50		Weekly
M[illegible]	San Francisco	[illegible]			15,[illegible] 00	None	15	5	10	8	12			None	Yes	10					$1 75		$1 25			Weekly
M[illegible]	Eureka	M[illegible]	2,[illegible]	[illegible]	18,[illegible] 00	N[illegible]	12	25	None	5 boys	12	...		None	Yes.	5	No.		2 00		2 00		1 25		Monthly.
[illegible]	Eureka	[illegible]	[illegible] 0																						Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	100 00	[illegible]	[illegible]	10			6				No		No.		[illegible] 00		2 00				Weekly
[illegible]	San Francisco	[illegible]	24,[illegible]	[illegible]	40,[illegible]		70	45	4	6	12				Slightly.	5			[illegible] 00	1 75	2 25		7 00		Weekly
[illegible]	San Francisco	[illegible]	[illegible]	40,[illegible]	60,000 00	$1[illegible]	100	5		...					No		No		[illegible] 00	87½	1 00	[illegible]	50	50	Weekly
[illegible] K	San Francisco	[illegible]	[illegible]	1,[illegible]	1,[illegible]		4	4			12								[illegible] 50						Weekly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	23,000 00	Not a cent	150	50	1[illegible]	None	10		2	None	No.		No.		2 50	1 00	2 00	90			Weekly
[illegible]	San Francisco	[illegible]			24,000 00		62								No.		No		[illegible]00 to 4 00		[illegible] 00				Weekly.
[illegible]	Stockton	[illegible]	[illegible]		4[illegible],100 00		60	47			12								3 75		2 50				Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	5,[illegible]		12	8		[illegible]	11	1			No		No.		2 25				1 00		Weekly
[illegible]	Stockton	[illegible]	[illegible]		17,000 00		37	28			12				No		No.		[illegible] 25		[illegible] 50				Weekly
[illegible]	Stockton	Agricultural [illegible]	[illegible]	[illegible]	[illegible]	Not [illegible]	45	30			8	4			No.		No		[illegible] 50		[illegible] 00		1 00		Weekly
[illegible]	Stockton	Agricultural [illegible]		[illegible]	[illegible] 00		12								No		No		[illegible] 00						Weekly.
[illegible]	[illegible]	[illegible]	12,[illegible]	[illegible]	[illegible]	$[illegible]	150	10	10	20		2	7	[illegible]	No		No.		2 50	1 00	1 50	[illegible]	[illegible]		Weekly
[illegible]	Mo[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		2	1			12								2 00		1 00				Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]	Nothing	22	22			12				No.		No		2 50		1 50				Weekly
[illegible]	Modesto	[illegible]	[illegible]	[illegible]	[illegible]	Not a dollar	5	3	None	None	8		1	None	No.		No		3 00		2 00				Weekly
[illegible]	Amador	[illegible]	[illegible]	[illegible]	[illegible]	$41,77[illegible] 00	25	20	None	None	6½		½	12	No		No		2 50		1 50				Monthly.
[illegible]	San Francisco	[illegible]		[illegible]				2		2 boys									2 00						Weekly.
[illegible]	San Francisco	[illegible]					42		9			2							2 50	1 00 to 1 66⅔		[illegible]			Weekly
[illegible]	[illegible]	Agricultural [illegible]	[illegible]	[illegible]	[illegible]		6	1			12								3 00		1 00				Monthly.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,[illegible]	None			None		7		2						[illegible] 00		[illegible]				Monthly.
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]		170	0	40	[illegible]	12			[illegible]	No		No		[illegible] 00	1 75	[illegible] 00	[illegible]	1 00		Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]	None			[illegible]		9			None	No		No		[illegible] 00	1 50					Weekly
[illegible]	San Francisco	[illegible]			[illegible]	None		1			6	6			Yes		No		[illegible] 00		1 50				Weekly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]	$6[illegible] 00	110	80	10	20	12			10	Yes.				[illegible] 50	1 50	2 50	[illegible]		[illegible]	Weekly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]	Nothing	[illegible]	100	None	[illegible]	12			None	No.		No		[illegible] 00		2 00		1 00		Weekly.
[illegible]	San Francisco	[illegible]			[illegible]	None	[illegible]		None		12									1 50					Monthly.
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	168,[illegible]		[illegible]	[illegible]	2	71	12			None	No		No		[illegible] 00		[illegible] 00	[illegible]	[illegible] 00	[illegible]	Weekly
[illegible]	San Francisco	[illegible]				None	[illegible]	7	None	2	12			None			No		[illegible] 00						Weekly
[illegible]	San Jose	[illegible]	[illegible]	6,[illegible]	1,[illegible]		1				12								[illegible] 50		[illegible] 50				Weekly.
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	12				Yes	15			[illegible] 25		[illegible] 50		1 50		Weekly
[illegible]	Oakland	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	220		[illegible]	12			None	No		Yes	10	1 50		1 75		1 00		[illegible] monthly.
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	24,000 00		[illegible]	40	None	[illegible]	12			None	No.		No		1 50		[illegible]				[illegible] monthly
[illegible]	Oakland	[illegible]	4,[illegible]	[illegible]	54,[illegible] 00	None	[illegible]	42	24	5	12			None	Yes	15	No		2 50	1 75	1 50	[illegible]			Weekly
[illegible]	San Francisco	[illegible]			[illegible]	None	[illegible]	100	None	[illegible]	12			None	No		No		[illegible]		[illegible] 00		[illegible]		Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible],000 00	Nothing	[illegible]	6						None	No		No		[illegible] 00		[illegible] 50				Weekly
[illegible]	San Francisco	[illegible]	[illegible]		[illegible]	Nothing	[illegible]	400	None	None	12			None	No		No		[illegible] 00		[illegible] 50				Monthly
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	None		4	None	None	12				No		Yes	10	2 50						Weekly
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		1	12			2				No		No		1 00		[illegible]				Monthly
[illegible]	San Francisco	[illegible]	25,[illegible]	[illegible]	24,[illegible]	None	10	2[illegible]	None	4 boys	12				No		No		2 50		[illegible]		[illegible]		Monthly.
[illegible]	San Francisco	[illegible]	[illegible]		[illegible]	None	25	20		21	4				No.		No		[illegible] 00		[illegible] 00		[illegible]		Weekly
[illegible]	San Francisco	[illegible]	[illegible]		[illegible]	None	0	0	None	None	12			None	No		No		[illegible]		[illegible] 50				Weekly
[illegible]	Nap[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$[illegible]	[illegible]	8	None	None	12			12	Yes		No		[illegible]		[illegible]				Monthly
[illegible]	San Francisco	[illegible]	[illegible]	[illegible]	[illegible] 00	None	20	[illegible]	None	2 boys	2				No		No.		10		[illegible] 00		[illegible]		Weekly
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		1	1				None	None		No			1 50		[illegible]	[illegible]	1 00	Monthly

CHAPTER VI.

EMPLOYERS AND EMPLOYÉS.

Accompanying the circulars sent to the County Assessors, which have been referred to in the preceding chapter, were three forms, styled respectively Forms "A," "B," and "C." The Assessors were asked to distribute them, and it is presumed that in some cases this was done; but in order to make assurance doubly sure, these same forms were sent broadcast to the different employers, employés, and labor organizations. Copies of these blanks are herewith appended:

Form A.

To be answered by Employers of hands, etc.

1. What is the name of your firm?
2. In town of?
3. What articles do you manufacture?
4. How much capital have you invested in your business? $——.
5. What are the value of goods manufactured at your establishment in the last twelve months? $——.
6. How much have you paid for labor in the last twelve months? $——.
7. How much have you paid for labor to Chinese employés? $——.
8. What is the greatest number of hands employed at one time during last year?
9. What is the average number of white males employed over sixteen years of age?
10. What is the average number of white females employed over fifteen years of age?
11. What is the average number of boys and girls employed?
12. Give the number of months run on full time? ——. Half time? ——. Idle?
13. What is the average number of Chinese hands employed in the last twelve months?
14. Have wages been advanced? ——. What per cent?
15. Have wages been reduced? ——. What per cent?
16. What has been the average day wages for skilled work: Men? $——. Women? $——.
17. What has been the average day wages for ordinary labor: Men? $——. Women? $——. Boys? $——. Girls? $——.
18. How are wages paid: Weekly?—— Or monthly?
19. If you have any information, or suggestions to make, which will be of advantage to the State, or to your business, please do so.

Form B.

To be answered by Employés, etc.

Dear Sir: You are respectfully requested to return this blank to this office (or to the Assessor of your county), with answers to each of the questions, at your earliest convenience. It will be strictly confidential, and no name will be mentioned in my report to the Legislature. It will be of the greatest importance to the wage-worker to obtain a full and explicit answer.

JOHN S. ENOS, Commissioner.

1. Your name?
2. Place of residence?
3. Occupation?
4. Nationality?
5. Are you married, or single?
6. If married, how many in your family depend on your support?
7. What is the name, or firm, of your employer?
8. Did you serve an apprenticeship to learn your trade, and if so, how long?

9. Do you work by the day, or by the piece?
10. How many hours constitute a day's work where you are employed?
11. How much do you earn per day, or per week?
12. How many days did you lose during the last twelve months by sickness?
13. How many days during the last twelve months were you unable to obtain employment?
14. Do you derive any assistance from the earnings of your wife, or children?
15. If so, how much in the last twelve months?
16. What employment does your wife and children have?
17. What wages are paid them?
18. How many of your children attend school?
19. Do you own the dwelling you live in?
20. If not, how many rooms do you occupy, and how much rent do you pay?
21. Of how many stories is the building in which you work?
22. What provisions exist for escape in case of fire in the factory where you work?
23. How many persons work in it?
24. Have you been implicated in any strikes in the last twelve months?
25. If so, what caused the strike?
26. How did it end?
27. How many days work did you lose by the strike?
28. Are girls and women employed in the place you work?
29. If so, how many?
30. Their wages?
31. Are boys under sixteen employed there?
32. If so, how many?
33. Their wages?
34. Are girls under fifteen employed there?
35. If so, how many?
36. Their wages?
37. Is your occupation unhealthy?
38. From what cause?
39. Are you a member of any benevolent society?
40. How much per week do you receive in case of sickness?
41. Have any considerable number of workmen been discharged the last twelve months from the place where you work?
42. If so, for what reasons?
43. Have you saved anything out of your earnings the last twelve months?
44. If so, what per cent of your earnings?
45. It is often stated that you don't receive a just profit on your labor; what better system can you suggest?
46. If possible, give actual (if not, estimated) expenses for the last twelve months, as follows: For rent, $——; fuel, $——; clothing, $——; groceries, $——; meats, $——; sundries, $——.
47. How many Chinese are employed at the place where you work?
48. If any, what wages do they earn?
49. If employed, do they work in the same room with you?
50. Or are any in the same room with the women or children?
51. Can you suggest anything that will improve the condition of the wage-worker in general? If so, please state it distinctly?

Form C.

To be Answered by Presidents of Labor Organizations.

We are desirous of collecting statistics relating to labor organizations within the State, and wish to put ourselves in direct communication with these societies. We trust that your society will afford us every facility. Please fill out these blanks at an early day and return to this office.

The answer to any inquiry will be regarded as strictly confidential, if desired.

Yours respectfully,

JOHN S. ENOS, Commissioner.

Name of organization?
No.? —— Located at?
County of?
Date of organization? ———, 188 .
Trade?
Meet when?
Number of members?
Name of M. W. or President?
Post Office address?

Is your organization connected with any State, National, or International organization? If so, give name of same?

Give name and Post Office address of some officer or person connected with each of such other organizations?

Please inclose copy of your constitution and by-laws.

As the best method of presenting the answers to Form "A" I have prepared them in tabulated form.

Of Form "B" there were sent out from this office over 10,000 blanks, of which fully 80 per cent were answered by the Central Pacific Railroad Company employés, leaving but 20 per cent answered by the general laborer, and furnishing another instance of the difficulty met with in gaining information directly from those who should be the most interested in giving it. It would be impossible to find space in this report for the answers to this enormous number of replies, so I have selected the most representative, condensing them generally, and where possible reporting the remarks and suggestions of the answers in their own words:

WORKINGMEN'S RETURNS.

ANSWERS TO FORM "B."

C. R., barber.—I served an apprenticeship; work 14 hours per day; when employed earn $18 per week; occupation not very healthy; am a member of a benevolent society, and when sick receive $30 per month. It is the unanimous desire of the barbers' association that a law should be enacted compelling the barber shops to be closed at noon on Sunday.

R. C., boilermaker.—Work by the hour; wages, 37½ cents per hour; 9 hours constitute a day's work. I am a member of a benevolent society, and receive $18 per week in case of sickness. Would recommend the coöperative system, and less hours of labor per day for the laboring classes.

F. W., brakeman, Central Pacific Railroad.—Work by the month; from 1 to 24 hours constitute a day's work when employed; receive $65 per month. I do not think laborers in general receive enough pay for the amount of work performed in our business. It is dangerous and consumes all of our time.

J. G., brushmaker.—Ten hours constitute a day's work; wages, $2 50 per day.

E. D., brickmaker.—I served an apprenticeship to learn my trade; manufacture brick; 7 hours constitute a day's work; $2 50 for skilled white labor; occupation is healthy.

D. McS., boot and shoe cutter.—Worked 5 years as an apprentice; work by the week; 10 hours constitute a day's work; receive $20 per week; belong to a benevolent society, and receive $15 per week in case of sickness; 18 men employed where I work; no one has been discharged for want of work; steady employment for sober men. In answer to question 45, following answer: "Coöperation or abolition of profit on original investment." In answer to question 51, he says: "Henry George's system of free lands; the issuance of governmental treasury notes for internal improvements, and the calling in of the same by an easy system of taxation, and mechanical industrial instructions in our public schools."

J. C., blacksmith.—Work by the day; 10 hours constitute a day's work; wages $2 35 per day. In answer to question 52 he says: Do away with work-saving machinery and it will do much to solve the problem.

M. W. G., can maker.—Ten hours constitute a day's work; work by the day or by the piece; worked 4 years as an apprentice to learn my trade; work in the Los Gatos Fruit Packing Company; it employs 150 hands; I earn from $4 to $5 per day; am satisfied with my wages.

C. E. B., compositor.—Work for the *Examiner* Publishing Company; served an apprenticeship of 7 years; day's work constitutes, on the average, 12 hours. In answer to question 52, he says: In the printing business, a stringent apprentice system controlled by the State would benefit the wage-worker.

J. P. M., collar and harness maker.—Served an apprenticeship to learn my trade; work by the piece; 10 hours constitute a day's work; I earn, when employed, from $2 50 to $3 per day. In answer to question 45 he says: A coöperative government system in the place of the present one, would insure us a just profit on our labor; and in answer to question 52 he says: The abolishment of convict labor in all mechanical pursuits, the exclusion of Chinese laborers from the American continent, and a high tariff.

G. N. H., horse-collar maker.—Served for 2 years as an apprentice; work by the day; 10 hours constitute a day's work; $15 per week; my occupation is unhealthy, from too much work and bad Chinese breath. In answer to question 45 he says: Less hours, more pay, and better luxury. In answer to question 52 he says: Less hours, more pay, abolish State Prison convict labor, and advance wages in all mechanical pursuits.

E. McC., carpenter and joiner.—Served as an apprentice 6 years; work by the day; 9 hours constitute a day's work; $3 50 per day. In answer to question 52 he says: Eight hours per day; and the Legislature should pass a law to prevent the employment of minor children of tender age in workshops, as injurious to their health and welfare.

H. C., horse-collar maker.—Served as an apprentice 7 years; work by the piece 10 hours a day, and receive $12 per week; my occupation is very unhealthy, hard, and laborious. In answer to question 52 he says: The working of convict labor is the principal curse of the harness and collar business, and I would suggest that the Directors be restrained from selling their products below the actual cost of production at wages that force us into idleness three months in the year, and compels us to work for less than gives us a living.

J. E. C., calker.—Served 7 years as an apprentice; work by the day; 9 hours constitute a day's work, and wages $5 per day; my occupation is healthy, as I am in good air. In answer to question 52 he says: "Low freight and iron ships make work scarce; this is due to the displacement of wooden ships. The railroad overland transportation is another feature of competition impossible to overcome. We have no suggestions to make, as it would be useless under the circumstances."

J. K., cigarmaker.—Served 5 years to learn my trade; work by the piece; 9 hours constitute a day's work; wages from $1 50 to $3 25 per day; boys under 16 receive $3 per week; my occupation is not very healthy from confinement and want of fresh air. In answer to question 52 he says: "Let the Chinese go, and the manufacturer would then obtain a better price for his goods and be able to pay better wages to his employés."

W. C. B., clerk S. P. C. R. R.—Work by the month, and 8 hours constitute a day's work; $75 per month; occupation somewhat unhealthy from close confinement and sewer gas. In answer to question 52 he says: "Save your money, get thoroughly posted in business, and when possible make a start for yourself."

G. G. R., farmer.—Work for my board and clothes; 10 hours are a day's work; am a member of three benevolent societies, and receive $6 a week in case of sickness. In answer to question 52 he says: "By employing white labor at fair wages, and not working more than 10 hours per day, with good food and kind treatment."

M. D., fireman.—Work by the month at $70 per month; 15 hours constitute a day's work. In answer to question 52 he says: "The only thing I can suggest is that hiring a man by the month and working him almost night and day, and Sundays, is entirely wrong and unjust."

T. M. L., section foreman, R. R.—Served 7 years as an apprentice; work by the day at $3 per day; 11 hours constitute a day's work.

F. W., pattern maker.—Served 5½ years as an apprentice; work by the day or piece. In answer to question 45 he says: "Abolish the competition system and establish coöperation in its place." In answer to question 52 he says: "Abolish national banks; let the government issue and loan all the money direct to the people at 1 per cent (as they do to the banks now) through the Post Office department; make all money a full legal tender, and when worn out replace it with new; change the election laws so minorities may be represented; establish a graduated tax law; limit land-holding to 160 acres. Make these changes and the laboring men and mechanics will paddle their own canoe."

J. M. S., engineer C. P. R. R.—Work by the month, at $90; 14 hours constitute a day's work. In answer to question 45, he says: "Less hours a day." And in answer to question 52, he says: "I can't suggest anything with the position I am holding at present."

W. Y., harness and saddlery.—Work by the day; $16 per week; 10 hours constitute a day's work; am a member of a benevolent society, and when sick am taken care of.

S. H. E., horse-collar maker.—Work by the day; 10 hours constitute a day's work; wages, $4 per day. In answer to question 52, he says: "More wages, less work, and an occasional dose of dynamite."

W. E. D., harnessmaker.—Served 5 years as an apprentice; work by the day; wages, $12 to $16 per week; 9 hours constitute a day's work. In answer to question 52, he says: "Abolish convict labor, keep sober, and make the heathen go."

P. K., laborer.—Work by the day; 10 hours constitute a day's work; wages, $2 25 per day; am a member of a benevolent society, and in case of sickness receive $10 per week. In answer to question 45, he says: "Higher wages and less hours."

B. E., varnisher and polisher.—Served an apprenticeship of 5 years; work by day or piece; when working, 10 hours constitute a day's work, and I receive from $2 50 to $3 per day; am a member of a benevolent society, and in case of sickness receive $7 per week. In answer to question 52, he says: By having first class men to take hold of shops, and not fourth rate men as now, then wages will be at a standard figure all the time.

J. D., lather.—Work by the day; 9 hours constitute a day's work; wages, $2 50 to $4 per day. In answer to question 52, he says: Get rid of the Chinese; I have lived in this State 23 years; 8 hours a day's work, can do as much work, and do it as well, as to work 10 hours; all mechanical laborers should not work over 8 hours per day. There is a good demand for labor then in this city, and a good demand for all working classes.

W. R., engineer.—Served as an apprentice 7 years; work by the month; wages $80 per month; 10 hours constitute a day's work; am a member of a benevolent society, and in case of sickness, receive $10 per week. In answer to question 52 he says: Send liberal-minded men to legislate for us, who have the interest of the producing element at heart, and who will put the organic law of our State in force, repeal the statutes which are opposed to the producing element, and then honest men will get their own.

T. H. D., printer.—Served an apprenticeship 7 years; work by the day, 10 hours constituting a day's work; wages $18 per week.

K. C., porter C. P. R. R.—Three years apprenticeship; work by the month; wages $12 50 per week; 14 hours constitute a day's work. Am a member of two benevolent societies, and receive $10 per week when sick. In answer to question 52 he says: In no condition to suggest anything, unless remuneration for the extra time, 14 hours being a little too long a time for a day's work.

J. J., machinist.—Served 4 years apprenticeship; work by the hour; 9 hours constitute a day's work; wages, $2 and $3 per day; belong to a benevolent society, and receive $10 per week when sick. In answer to question 52 he says: stop all foreign cheap labor emigrants, less lawyers to rob the employés, so they will not have to rob their employers or the government, so that we are taxed to death.

P. J. G., iron molder.—Served 4 years as an apprentice; work by the day, at $3 50 per day; 10 hours constitute a day's work; my occupation is unhealthy, as there is too much dust. In answer to question 52 he says: 8 hours for labor, 8 hours for pleasure, 8 hours for sleep, and temperate habits.

N. A. F., machinist.—Served 7 years as an apprentice; work by the piece; 9 hours constitute a day's work. In answer to question 52 he says: Revolutionize the present system of competitive labor and inaugurate in its stead socialistic governmental coöperation.

W. J. S., grain weigher and sampler—Work by the week at $25 per week—9 hours per day. In answer to question 45 he says: A proportionate share of profits with my employer, and an abolishment of the wage system.

W. W., machinist.—Work by the hour; 9 hours constitute a day's work; 38 cents per hour. In answer to question 45 he says: That the Government own and run the railroad. In answer to question 52 he says: Prevent land monopoly and the importation of cheap foreign labor, both Asiatic and European.

J. D. C., tinsmith.—Served 7 years as an apprentice; $2 to $5 per week; am a member of a benevolent association, and receive $30 when sick.

J. B., sailmaker.—Work by the day at $4 per day; 9 hours constitute a day's work. In answer to question 52 he says: "I believe in a standard basis of wages, and think that no one man should perform more work than another in any craft for the same wages."

G. Y. B.—In answer to question 52 he says: "Be temperate, economical, and industrious, fear God, and do unto others as he would that others should do unto him."

L. C. G., sash, door, and blindmaker (foreman).—Work by the day and month; 10 hours constituting a day's work; earn $8 per day; am a member of a benevolent society, and in case of sickness receive $36 per week. In answer to question 52 he says: "Let labor work to the interest of the employer, and provide means by which labor shall be paid promptly, and in cash, and labor not be compelled to buy goods at a store that the employer owns, thus depriving labor of the chance of buying cheap."

E. K. R., blacksmith.—Served 6 years as an apprentice to learn my trade; work by the day; 10 hours constituting a day's work, and earn $3 per day; am a member of a benevolent society, and in case of sickness receive $10 per week; have saved 25 per cent of my year's earnings.

M. K., woodworker.—Work by the day; 10 hours being a day's work, and earn $2 per day; about 60 persons work in the factory in which I am employed; about 15 boys under 16 years are employed, who receive from 50 cents to $2; 20 Chinese are also employed, who make $1 per day.

D. M., driller.—Served 16 years as an apprentice to learn my trade; work by the hour; 9 hours being a day's work; earn 30 cents per hour, $2 70 per day. In answer to question 52 he says: "Prevent land monopoly, and the importation of cheap foreign labor, both Asiatic and European."

M. G., superintendent of an orchard.—Work by the year, and earn $1,200 a year; 50 persons work on the same place, including women and girls; they make from 25 cents to $1 per day. In answer to question 52, he says: Let whisky and gambling alone, and make expenses a little less than income.

J. M. P., yardman, railroad.—Work by the month; 11 hours constituting a day's work; earn $70 per month. In answer to question 52, he says: The honest fulfillment of all laws, as they exist, especially the Restriction Act, and a moderation of the tariff on some articles.

J. E. E., superintendent of mine, and assayer and mining engineer.—Work by the year, and earn about $46 per week; working underground, 9 hours constitute a day's work, and working on the surface, 10; 30 Chinese work at this place, and 25 white men; Chinese receive $1 25 per day; white labor, $3 to $3 50 per day; am a member of a society, and when sick receive $30 per week.

V. J. E., station agent.—Have been an apprentice over 9 years, and still learning; work by the month, and at present 13½ hours constitute a day's work; earn about $65 and house rent per month; am a member of a benevolent society, and in case of sickness receive $8 per week. In answer to question 45, he says: I suggest, first, more liberal compensations for those who work with hands and heads, coupled with a more discriminating selection and apportionment of the workers; second, sure promotion for faithful service. This would directly benefit the faithful worker, and indirectly the other one, by stimulating him to efforts in the direction of the same benefit.

COST OF LIVING.

The following answers were received to Question 46 of Form "B," sent to employés in the different branches of industry. The question referred to is:

46. If possible give actual (if not, estimated) expenses for the last

twelve months, as follows: For rent, $——; fuel, $——; clothing, $——; groceries, $——; meats, $——; sundries, $——.

Name.	Occupation.	Cost of Living for Twelve Months.					
		Rent.	Fuel.	Clothing.	Groceries.	Meats.	Sundries.
H. C.	Collar maker	$96 00	$30 00	$50 00	--------	--------	$150 charity to fellow workers
J. A. A.	Deck hand	120 00	150 00	$100 00	$150 00	$150 00	100 00
J. L.	Section foreman	--------	30 00	185 00	50 00	101 00	75 00
W. J. S.	Grain weigher	96 00	--------	200 00	--------	--------	700 00
J. F.	Deck hand	--------	--------	150 00	--------	--------	25 00
A. G. W.	Machinist	144 00	80 00	115 00	300 00	72 00	10 00
J. G.	Machinist	84 00	24 00	72 00	--------	--------	192 board, etc.
J. C.	Tinsmith	240 00	30 00	125 00	12 00	100 00	--------
J. McL.	Trader	--------	40 00	150 00	150 00	50 00	500 00
G. J. G.	Watchman	144 00	50 00	175 00	300 00	150 00	--------
G. W.	Engineer	192 00	60 00	500 00	460 00	360 00	200 00
De W. C. S.	Journalist	150 00	20 00	150 00	70 00	150 00	--------
J. M.	Iron molder	--------	50 00	200 00	400 00	100 00	200 00
J. C.	Blacksmith	--------	60 00	250 00	370 00	110 00	100 doctor bills
S. H. E.	Horse-collar maker	90 00	10	100 00	05	--------	1,100 00
M. D.	Fireman	72 00	25 00	120 00	180 00	208 00	305 00
J. E. C.	Calker	--------	40 00	100 00	250 00	100 00	300 00
L. C. G.	Sash, door, and blind maker	--------	--------	--------	--------	--------	75 board and room per m'th
J. C.	Blacksmith	--------	10 00	20 00	200 00	50 00	15 00
R. H. B.	Foreman S. L. Co.	--------	50 00	40 00	400 00	100 00	250 00
E. K. R.	Blacksmith	--------	25 00	100 00	100 00	50 00	385 including tuition, board girl at school
J. W.	Deck hand	120 00	30 00	150 00	300 00	100 00	50 00
T. H. L.	Section foreman	--------	6 00	300 00	180 00	--------	120 board and schooling of children in N. Y., $300
P. J. F.	Iron molder	144 00	12 00	100 00	350 00	120 00	--------
C. E. B.	Compositor	240 00	50 00	150 00	250 00	200 00	50 00
W. R.	Engineer	180 00	48 00	50 00	300 00	--------	--------
N. A. F.	Machinist	180 00	25 00	30 00	--------	--------	--------
R. C.	Boilermaker	96 00	9 00	100 00	--------	--------	548 board for self and 3 boys
F. W.	Brakeman	100 00	--------	175 00	--------	--------	260 for board
K. C.	Steamboat porter	72 00	72 00	90 00	240 00	120 00	6 00
J. J.	Machinist	--------	40 00	200 00	250 00	100 00	200 for insurance and doctor bills.
J. K.	Cigarmaker	50 00	--------	100 00	--------	--------	250 for board
W. C. B.	Clerk	240 00	36 00	200 00	180 00	100 00	--------
J. J. R.	Farmer	--------	60 00	500 00	300 00	150 00	30 00
Wm. T.	Harness and saddlery	120 00	30 00	150 00	150 00	150 00	100 00
E. McC.	Carpenter and joiner	144 00	50 00	150 00	35 00	14 00	150 for doctor and medicine
G. H. H.	Horse-collar maker	60 00	--------	80 00	--------	--------	140 00
D. McS.	Boot and shoe cutter	192 00	36 00	60 00	318 50	91 00	342 50
J. D.	Lather	96 00	20 00	50 00	48 00	96 00	21 00
B. E.	Varnisher	250 00	50 00	150 00	200 00	100 00	100 00
D. M.	Driller	136 00	50 00	--------	240 00	96 00	--------
G. Y. B.	--------	600 00	100 00	250 00	300 00	240 00	1,200 00
V. J. E.	Station agent	--------	40 00	200 00	450 00	30 00	50 00

Cost of Necessaries.

Retail Prices in San Francisco Compared with Massachusetts and Great Britain.

Articles.	San Francisco.		Massachusetts.		Great Britain.	
	Quantities	Average Retail Prices	Quantities	Average Retail Prices	Quantities	Average Retail Prices
Groceries.						
Flour, wheat, superfine	Pound	$0.025	Pound	$0.041	Pound	$0.036
Flour, wheat, gilt edge	Pound	.03	Pound	.036	Pound	.033
Flour, rye	Pound	.02	Pound	.025	Pound	.022
Corn meal	Pound	.03	Pound	.027	Pound	.018
Codfish, dry	Pound	.08	Pound	.102	Pound	.085
Rice	Pound	.06	Pound	.085	Pound	.056
Beans	Quart	.06	Quart	.113	Quart	.075
Tea, Oolong	Pound	.70	Pound	.539	Pound	.646
Coffee, Rio, green	Pound	.25	Pound	.173	Pound	--------
Coffee, roasted	Pound	.35	Pound	.209	Pound	.354
Sugar, good brown	Pound	.085	Pound	.08	Pound	.06
Sugar, coffee	Pound	.095	Pound	.09	Pound	.066
Sugar, granulated	Pound	.10	Pound	.095	Pound	.078
Molasses	Gallon	1.00	Gallon	.697	Gallon	.576
Syrup	Gallon	.50 to .85	Gallon	.781	Gallon	.708
Soap, common	Pound	.07	Pound	.08	Pound	.058
Starch	Pound	.09	Pound	.107	Pound	.095
Oil, kerosene	Gallon	.20	Gallon	.186	Gallon	.17
Provisions.						
Beef, roasting	Pound	.12 to .15	Pound	.169	Pound	.228
Beef, soup	Pound	.06 to .10	Pound	.079	Pound	.151
Beef, rump steak	Pound	.15 to .20	Pound	.255	Pound	.27
Beef, corned	Pound	.10 to .15	Pound	.105	Pound	.178
Veal, fore quarter	Pound	.08 to .12	Pound	.11	Pound	.206
Veal, hind quarter	Pound	.12 to .18	Pound	.151	Pound	.24
Veal, cutlets	Pound	.15	Pound	.204	Pound	.252
Mutton, fore quarter	Pound	.07 to .08	Pound	.111	Pound	.195
Mutton, leg	Pound	.12 to .15	Pound	.161	Pound	.227
Mutton, chops	Pound	.15 to .18	Pound	.185	Pound	.25
Pork, fresh	Pound	.15 to .18	Pound	.12	Pound	.182
Pork, salted	Pound	.10 to .15	Pound	.118	Pound	.176
Pork, bacon	Pound	.12 to .15	Pound	.17	Pound	.172
Pork, hams, smoked	Pound	.14 to .16	Pound	.15	Pound	.225
Pork, shoulders, corned	Pound	.10 to .15	Pound	.127	Pound	.20
Sausages	Pound	.15 to .20	Pound	.131	Pound	.167
Lard	Pound	.12 to .15	Pound	.124	Pound	.186
Mackerel, pickled	Pound	.10 to .15	Pound	.134	Pound	.07
Butter	Pound	.30	Pound	.302	Pound	.347
Cheese	Pound	.15 to .25	Pound	.145	Pound	.16
Potatoes	100 lbs.	1.00 to 1.50	Bushel	.747	Bushel	.66
Milk	Quart	.10	Quart	.071	Quart	.073
Eggs	Dozen	.20 to .30	Dozen	.36	Dozen	.39
Fuel.						
Coal	Ton	8.00 to 16.00	Bushel	.248	Bushel	.121
Wood, hard	Cord	9.50 to 10.00	Foot	.822	----------	--------

The cost of living in San Francisco will be found in the bills of fare of two of our leading dining saloons, who furnish 8,000 meals daily:

ROYAL DINING SALOON, SAN FRANCISCO.

BILL OF FARE.

Cooked to Order.

Family porterhouse (large)	75	Mutton cutlet, breaded	10
Family porterhouse	50	Lamb chops	10
Porterhouse steak	35	Pork chops	10
Tenderloin steak	35	Domestic sausage	10
Sirloin steak	25	Fried brains, plain or in batter	10
Rump steak	25	Fried tripe	10
Beefsteak and onions	10	Fried bacon, with or without apples	10
Beefsteak, plain	10	Liver and bacon	10
Beefsteak, Spanish	10	Bean omelette	10
Half spring chicken, broiled	50	Pigs' feet, soused or in batter	10
Veal cutlet, plain or breaded	10	Corned beef hash	10
Mutton chops	10	Fish cakes	10

Weiner schnitzel, with tea or coffee, 25 cents.
Baked pork and beans, with Boston brown bread, 10 cents.

Oysters.

Oyster stew	25	Raw oysters	25
Oyster omelet	50	Oysters in crumbs	35
Oyster fritters	25	Oysters in batter	35
Scalloped oysters	25	Select Eastern oysters, any style	50

LUNCH AND DINNER.

Salads.

Chicken and crab a la mayonaise	10	Lobster a la Delmonico	10
Potato	Free		

Soup.

Mock turtle	10	Vegetable	10
Chicken	10	Mutton broth	10
Boullion	10	Rice tomato	10
Oyster	10		

Fish.

Boiled rock cod and egg sauce	10	Baked halibut, tomato sauce	10
Salmon, baked, boiled, or fried	10	Salt codfish, boiled	10
Sea bass or flounder	10	Mackerel, boiled or broiled	10
Tenderloin of sole	10	Smelts, tom cods, or herring	10
Boneless smelt	10	Baked flounders	10

Cold Meats.

Roast chicken	35	Boiled ham	10
Roast turkey	35	Pressed corned beef	10
Soused pigs' feet	10	Roast mutton	10
Turkey, cranberry sauce	35	Chicken, giblet sauce	35

Roasts.

Turkey, cranberry sauce	35	Veal	10
Chicken stuffed	35	Pork	10
Beef	10	Mutton	10
Chicken, oyster sauce	25	Mutton and turnips	10

Boiled.

Chicken, egg sauce	25	Corned beef and cabbage	10
Chicken, parsely sauce	25	Corned pork and cabbage	10
Mutton, caper sauce	10	Mutton and turnips	10
Mutton, mint sauce	10	Boiled New England dinner	15

Entrees.

Chicken fricassee a l'alamande	25	Corn beef hash a l'anglaise	10
Chicken potpie a la dauphine	25	Baked veal and oyster pie	10
Pig's head and cabbage	10	Calves head, sauce piquante	10
Breast of lamb breaded and succotash	10	Spring lamb curried and rice	10
Roll of beef and Lima beans	10	Beef a la mode, with carrots	10
Baked lamb's brains, tomato sauce	10	Spring lamb fricassee, with pease	10
Frankfwiter sausage and red cabbage	10	Blanc mange fritters, citron sauce	10
Sirloin of beef larded and macaroni	10	Boiled beef, horseradish sauce	10

Stews.

Chicken	25
Brains	10
Kidney	10
Tripe	10
Veal	10
Mutton	10
Beef	10

Vegetables.

Green peas	10
Tomatoes	10
Green corn	10
String beans	10
Tomatoes, stewed	10
Red cabbage	10
Succotash	10
Cabbage	10
Onions	10
Spinach	10
Parsnips	10
Lima beans	10
Boiled onions	10

Fruit—All Kinds in Season.

Fresh grapes	10
Fresh figs	10
Strawberries and cream	10
Peaches and cream	10
Assorted fruit	10

Puddings.

Apple dumpling	10
Bread	10
Rice	10
Tapioca	10
Cabinet	10
Peach roll	10
New York plum	10
Corn starch	10
Cup custard	10
Rice custard	10

Pies.

Apple	10
Custard	10
Peach	10
Plum	10
Cranberry	10
Cocoanut cream	10
Lemon cream	10
Strawberry	10
Squash	10

Cakes.

Citron	10
Sponge	10
Cream	10
Pound	10
Raisin	10
Jelly	10
Jelly roll	10

Desserts.

Peaches and cream	10
Cranberry sauce	10
Apple sauce	10
New comb honey	10
Hot mince pie	10
Stewed pears	10
Stewed plums	10
Baked apples	10
Stewed prunes	10
Banana fritters	10
Currant jelly	10
Bartlett pears	10
Stewed figs in wine	10
Ice cream	15

Wines and Liquors.

Geo. H. Mumm & Co's, qts	$4 50
" " pts	2 25
Table claret, per bottle	20
" half bottle	10
Extra California	50
" " half bottle	25
St. Julien Medoc	75
White wine, per bottle	25
" half bottle	10
Old sherry	1 50
Small champagne cider	15
California ale or porter	15
Port wine	$1 00
Champagne, imported, extra, qts	4 50
" " " pts	2 25
" California, qts	2 50
" " pts	1 50
Ale, per bottle, pts	25
Porter, per bottle, pts	25
Beer, per glass	10
Bottled beer	10
English ale or porter	25
Eastern cider	10

BREAKFAST AND SUPPER.

Fish.

Tom cod or rock cod	10
Salmon, fried or boiled	10
Sea bass	10
Tenderloin of sole	10
Mess mackerel	10
English sole	10
Fried smelts	10
Fried tom cod	10
Mackerel, boiled or broiled	10
Flounders or smelts	10

Eggs.

With tea or coffee.

Corn beef omelette with an egg	15
Three fried eggs	25
Three poached eggs on toast	25
Ham and two eggs	25
Three poached eggs	25

With tea or coffee.

Three scrambled eggs	25
Egg omelette (three eggs)	25
Rum omelette	25
Fried salt pork and eggs	25
Two boiled eggs	20

Hot Rolls, Muffins, etc.

Hot rolls	10
German rolls	10
French rolls	10
Hot corn cake	10
Coffee cake	10
Jenny Lind cake	10
Hot American waffles	10
German pancake, with coffee	25

Hot Cakes and Toast.

Buckwheat cakes	10
Flannel cakes	10
Corn batter cakes	10
Boston cream toast	15
Dry toast	10
Milk toast	10
Fried Indian pudding	10
Crushed Indian	10

Coffee, tea, chocolate, or milk	10
Coffee, tea, chocolate, or milk, with rolls or toast	15
Coffee, tea, chocolate, or milk, with pie or cake	15
Oat meal mush, cracked wheat, or crushed Indian, with milk	10
Oat meal mush, cracked wheat, or crushed Indian, with cream	15

Entrees.

Yankee buckwheat cakes, with maple syrup	15
Alameda snipe on toast, with tea or coffee	25
One half spring chicken, with tea or coffee	50
Cosmopolitan breakfast	25
English mutton chop	10
Home made sausage	10
Fried corn meal mush, with currant jelly	10
Pork tenderloin, with currant jelly	15
Pork spare rib, apple sauce	15
Kidney, saute a la bordeau	15
Apple fritters	10
Apple sauce	10
Pigs feet in crumbs or batter	10
Boston pork and beans	10
Boston cream toast	10
Chicken liver brochette on toast	10
Corned beef omelette, mushroom sauce	10
Tenderloin steaks	25
Quail on toast	25
Hulled corn and cream	10

Three 10 cent dishes to one person, 25 cents.
Two 10 cent dishes, with a cigar, 25 cents.

POPULAR DINING SALOON, SAN FRANCISCO.

DINNER BILL OF FARE.

Soups.

Scotch barley, Edinburgh style	10
Chicken	10
Boullion	10
Oyster	10
Vegetable	10
Mutton broth	10
Rice tomato	10

Fish.

Salmon, baked, boiled, or fried	10
Sea bass, baked, boiled, or fried	10
Tenderloin of sole	10
Salt codfish, boiled	10
Mackerel, boiled or broiled	10
Smelts, tomcods, or herring	10

Boiled.

Mutton, caper sauce	10
Mutton, mint sauce	10
Cold boiled ham	10
Corned beef and cabbage	10
Corned pork and cabbage	10
Mutton and turnips	10

Pot of tea or coffee, or glass of milk	10
Chocolate, cup	10

Chicken potpie	25
Veal potpie	10
Pigs feet soused	1
Breast of lamb breaded	10
Mutton curry and rice	10
Veal	10

Roasts.

Beef	10
Veal	10
Pork	10
Turkey	50
Chicken, half	50
Chicken, quarter	35
Mutton	10

Entrees.

Roast chicken, currant jelly, half	50	Brazed sirloins of beef and celery roots	10
Roast chicken, currant jelly, quarter	35	Baked macaroni and cheese a la Genoise	10
Chicken fricassee a la crême	25	Roll of beef and stewed sweet corn	10
Stewed chicken giblets, family style	10	Baked breast of Spring lamb and string beans	10
Roast Spring lamb and green peas	15	Boiled rump of beef and horseradish	10
Irish stew, Dublin style	10	Boiled New England dinner	10
Baked young veal and peas	10	Brazed shoulder of lamb and succotash	10
Beefsteak pie a la popular	10	Tenderloin of sole, tartar sauce	10
Stewed Spring lamb and sweet potato	10	Boiled fresh codfish, mustard sauce	10
Spare rib of Spring lamb and Lima beans	10	Potato salad free.	

Relishes.

Banana fritters	10	Apple fritters	10
Lobster salad	10	Chicken salad	10

Stews.

Brains	10	Mutton	10
Kidneys	10	Beef	10
Tripe	10	Chicken fricassee	25
Veal	10	Stewed chicken	25

Vegetables.

Green corn	10	Cabbage	10
Green peas	10	Onions	10
String beans	10	Spinach	10
Tomatoes	10	Mushrooms	25

Puddings.

Apple sago	10	Bread custard	10
Apple dumpling	10	Greengage roll	10
Bread	10	Apple roll	10
Rice	10	Cup custard	10
Tapioca	10	Corn starch	10
Plum	10	Indian	10

Pies.

Custard	10	Plum	10
Apple	10	Peach	10
Mince	10	Cranberry	10
Squash	10	Blackberry	10
Lemon cream	10	Strawberry cream	10
Cocoanut cream	10	Huckleberry	10
Hot mince	10	Grape	10

Cakes.

Citron	10	Pound	10
Sponge	10	Jelly	10
Cream	10	Jelly roll	10

Dessert.

Stewed huckleberries	10	Peaches and cream	10
Stewed prunes	10	Strawberries and cream	10
New honey	10	Raspberries	10
Baked apples	10	Baked pears	10
Stewed plums	10		

Wines.

Table claret, per bottle	25	Schlitz Milwaukee beer	25 and 50
Table claret, half bottle	10	Cantenac Medoc	50
Extra California	50	Haut Sauterne	50 and 1 00
St. Julien Medoc	75	Chateau Lafitte	50 and 1 00
White wine, per bottle	25	Chateau La Rose	50 and 1 00
White wine, half bottle	10	Sarsaparilla	10
Old sherry	1 50	Soda water	10
Port wine	1 00	Russ Cuvee	10
Champagne, imported, extra, quarts	4 50	Congress water	10
Champagne, imported, extra, pints	2 25	California ale or porter	15
Champagne, domestic, quarts	3 00	Ginger ale	10
Champagne, domestic, pints	1 50	Best Zinfandel	15 and 30
Ale, per bottle, pints	25	Vermouth	10
Porter, per bottle, pints	25	Anisette	10
Beer, per glass	10	Absinthe	10
Bottled beer	10	Cider	10

BREAKFAST AND SUPPER.

Cooked to Order.

Quail on toast	25
Family porterhouse	50
Half Spring chicken	50
Porterhouse steak	35
Rump steak	25
Sirloin steak	25
Tenderloin steak	25
Broiled quail	25
Weiner schnitzel and coffee	25
Veal cutlet, plain or breaded	10
Beef steak, plain	10
Porterhouse of veal	25
Beef steak, Spanish	10
Beef steak and onions	10
Mutton chops	10
Pork chops	10
Bacon, fried or broiled	10
Fried apples and bacon	10
Bean omelette	10
Mutton cutlets, breaded	10
Domestic sausage	10
Liver and bacon	10
Fried brains, plain	10
Fried brains in batter	10
Lamb chops	10
Pigs feet in batter	10
Corned beef hash	10
Fried smelts	10
Fried tom cod	10
Salmon, fried or broiled	10
Fish balls	10
Mackerel	10
Herring, fried or broiled	10
Tenderloin of sole	10

Baked pork and beans, with Boston brown bread, 15 cents.
Maple syrup, 5 cents.

Eggs and Oysters.

2 eggs, with tea or coffee	20
3 boiled eggs, with tea or coffee	25
3 fried eggs, with tea or coffee	25
Ham and 2 eggs, with tea or coffee	25
Ham and 3 eggs, with tea or coffee	30
Poached eggs on toast, with tea or coffee	25
3 scrambled eggs, with tea or coffee	25
3 omelette eggs, with tea or coffee	25
3 rum omelette eggs, with tea or coffee	35
Oysters in batter	25
Oyster fritters	25
Stewed oysters	25
Raw oysters	25
Oysters fried in crumbs	35
Select Eastern oysters	35

Hot Cakes, Muffins, Rolls, etc.

Buckwheat cakes	10
Flannel cakes	10
Milk, dry, or cream toast	10
Corn batter cakes	10
German pancake, with coffee	25
Doughnuts	10
Hot corn bread (morning)	10
German rolls	10
French rolls	10
Jenny Lind cake	10
Coffee cake	10
Hickory bread	10

Cake or pie, with coffee, tea, or chocolate, 15 cents.
Oat meal mush or cracked wheat, with milk, 10 cents.

Entrees.

Fried Spring chicken, with cream sauce	35
Baked pork and beans and Boston brown bread	10
Half Spring chicken broiled on toast	50
Fried or broiled rock cod	10
Boneless smelt	10
Flounders in any style	10
Corned beef hash and one egg	15
Fried calves liver, with bacon	10
Beef kidney broiled on toast	10
Bunker's club house sausage	10
Stewed tripe	10
American waffles	15
Scrambled brains, with an egg	15
Hamburg steak, with coffee	25
Stewed kidney	10
Fried or broiled tripe	10
Brains fried plain or in batter	10
German pancakes and coffee	25
Hulled corn in cream	10
Crushed Indian corn and cream	10
Ice cream	15

One 15-cent and two 10-cent dishes to one person for 30 cents.

The answers received to Form "C" were eminently unsatisfactory. Some 600 blanks were sent out, from which only the following ten were received:

LABOR ORGANIZATIONS.

Answers to Form C.

Name of Organization.	No.	Located at—	Date of Organization.	Trade.	Meets When.
Harness, Saddle, Collar, and Whipmakers	2,383	San Francisco	Dec., 1882	Harness and saddlery	
Miners' Union		Alleghany, Sierra	Nov., 1883		1st Saturday of each month
Ship Calkers' Association		44 Spear St., S. F.	Oct. 28, 1879		1st Wednesday of each month
Barbers' Protective Union		529 California, S.F.	Jan. 13, 1878	Barber and hairdresser	1st and 3d Tuesdays, each month
Varnishers and Polishers' Union of Cal.		927 Mission, S. F.	April 17, 1882	Varnishing and polishing	1st and 3d Wednesdays, each m'th
Iron Molders' Union	164	San Francisco	Jan. 30, 1867	Iron workers	2d and 4th Wednesdays, each m'th
Brotherhood of Locomotive Engineers	161	909½ Market, S. F.	Aug. 17, 1863	Locomotive engineers	2d and 4th Sundays, each month
Journeyman Tailors' Protective and Benevolent Union		San Francisco	Sept. 21, 1873	Tailors	2d & 4th Thursdays, each month
San José Branch of White Cigarmakers' Association of the Pacific Coast	1	San José	June 23, 1882	Cigar makers	1st Tuesday after 4th of each m'th
San Francisco Typographical Union	21	San Francisco	1872	Newspaper, book, and job printing	Last Sunday of each month

Name of Organization.	No. of Members.	Name of M. W. or President.	Post Office Address.	Is your organization connected with any State, National, or International organization? If so give name of same.	Give Name and Post Office Address of some officer or person connected with each of such other organizations.
Harness, Saddle, Collar, and Whipmakers		Jos. P. Mehn, M. W.	214 Battery Street	Knights of Labor of N. A.	F. Turner, L. B. 71, Philadelphia
Miners' Union	50	G. W. Hildebrand	Alleghany, Sierra, Cal	No	
Ship Calkers' Association	209	Robert L. Delano		No	
Barbers' Protective Union	130	Charles Rimassa	None	No	
Varnishers and Polishers' Union of Cal.	75	James W. Crowe	408 Shipley Street	No	
Iron Molders' Union	250	George Spring	216 Second Street	Iron Molders' Union, N. A.	P. F. Fitzpatrick, Int. President, Lock Box 388, Cincinnati, O.
Brotherhood of Locomotive Engineers	75	Jas. Madden, Ch. En.	S. P. R. R. Shops, San Francisco	B. of L. E.	P. M. Arthur, C.E., Room 5, Blackstone Block, Cleveland, O.
Journeyman Tailors' Protective and Benevolent Union	200	Eric Westine	316 Post Street, S. F.	No	
San José Branch of White Cigarmakers' Association of the Pacific Coast	28	J. W. Barcill	San José, Cal.	White Cigarmakers' Ass'n	
San Francisco Typographical Union	700	Jas. G. Piratsky	San Francisco	Int. Typographical Union	M. L. Crawford, Pres., Chicago, Ill.

As a sort of appendix, I present a series of reports on the condition of the labor market in San Francisco, under date of September, 1884, as made by the committees of Labor Councils:

CONDITION OF THE LABOR MARKET.

As reported by Committee of Labor Council, San Francisco, September, 1884.

PAINTERS.

The city is overstocked with painters who are willing to work for less than the fixed rate of wages. Those who have lived here for any length of time (many of them with families), have remained idle at least half the time since April last. This is not owing to any ill-feeling between employers and workmen, but to the over supply of journeymen, forcing them into competition with each other, to their mutual injury. Not more than fifty in the whole city will save anything this year. This out of one thousand five hundred permanent resident painters is not a good showing.

FREDERICK WARRILOW,
Recording Secretary Painters' Assembly 1903, K. of L.

Frank Nelson, painter, of 931 Market Street, states that he has been in San Francisco twenty-seven years, and never saw the trade so dull as it now is. Not one man in fifty is working. Has not put in a full week's work since July 3. The most work he has had in any one week was three and one half days. Has been entirely idle three weeks. Visits all the shops and knows their condition. Universal idleness from lack of work, prevails. Shops formerly employing forty men now have but five or six.

HARNESS MAKERS.

I am a harness maker of twelve years' experience and practice. I have lived ten years in seven of the Western States, and upwards of two years in California. I find this the hardest State to get a job I have yet been in. In fact, I cannot get any kind of a job at my trade at all, and I am going to return to Kansas in a few days, hoping that the glowing account of the great chances for the toiling masses in California may prove more of a reality to others than it has to myself.

San Francisco, September 10, 1884. J. R. MILLER.

COLLAR MAKERS.

I am a collar maker, employed at Main & Winchester's, and am Secretary of the Harness, Saddle, and Collar Makers' Union. I am constantly in communication with all branches of the trade. The trade is now in a very bad condition. One half of the collar and harness makers are now out of employment, and the other half are working 8 hours in most of the shops of the city.

San Francisco, September 12th. JAMES H. GILLESPIE.

TEAMSTERS.

Have lived forty-two years, and been in twenty-three States and Territories, and I find California the hardest place to get work in I have found in all my travels; besides, men are worked harder here than in any other State of the Union. I have been employed a little over half the time during two years' residence in California. I consider the chances in my business for a man to get a job are about one out of sixteen in good times, but much less now.

PETER CALWELL,
Corner Sixteenth and Guerrero Streets.

FARM LABORERS.

I am a farm laborer. I have followed the business for thirteen years in California, and get work about four months in the year, and work sixteen hours per day for an average of $30 per month. The balance of the time I work for my board, in any way to keep soul and body together. My clothes cost $12 per year on the average. As regards California being a good place for immigrants, I say no. Land and labor are both impossible to procure to afford an existence, unless poor grub, dealt out under a tree, and a large commodious haystack for a bed chamber, constitute the happiness that civilization affords in this great and glorious State.

JAMES JENKINS,
Practical farmer, 38 years old.

City Front Hotel, San Francisco.

PRINTERS.

There are fully one hundred printers out of work at the present time, and as many more that are only able to get work periodically. The outlook for the future is bad. A large number would leave the city if they had means to do so.

E. C. NEWHOFF,
Member of Committee.

BLACKSMITHS, CARRIAGE MAKERS, AND DRAYMEN.

Mr. Charles McArron, member of this committee and carriage maker at 820 Folsom Street, makes the following report of facts gathered from business men in different parts of the city:

House Smiths.—Business very dull, and a great many men idle.

CALVIN NUTTING & SON.

Ship Smiths.—Business never was so dull, or so many men unemployed.

H. CROCKER, 20 Folsom Street.

Carriage Smiths and Truck Makers.—Nothing at all doing.

CHRIS. SHULZ, corner Drum & Commercial Streets.

Business very dull. B. GALLAGHER, Mission Street.

No business doing whatever. T. D. S. LAMAR, 540 Valencia Street.

I make a similar report. C. McARRON, 820 Folsom Street.

Draymen.—Business dull and a great many men idle.

JOHN GORHAM, drives for Tubbs & Co.

Never knew so many men idle. DEXTER, hauls for Blake, Robbins & Co.

All cartmen report business very dull. C. McARRON, 820 Folsom Street.

COOPERS.

Patrick Buckley, cooper, resides at 1410 Harrison Street; has been in San Francisco six years; the trade is now in the slackest condition he has ever known; there is no work of any importance in the shops; the kegs made this season to sell to the farmers for the purpose of packing butter are now on hand, and no market for them. All the work he has done from the first of May to the present time (the middle of September) would not amount to a month. Not one fourth of the coopers are at work. There are coopers in the city who have walked the streets for six months, and have been unable to get a day's work during that time, either at their own trade or at any other employment.

WOOD CARVERS.

There are about seventy-five or eighty wood carvers in the city; of this number there are four or five who have had steady employment since January 1; the rest have worked about half time—some more and some less. Wages have averaged $2 50. I have been out of work eighty-three days since January 1; I am out of work now, with a prospect of remaining so for some time. One cause of the lack of work is the use of zinc cornices on buildings in place of wood. Another cause is the fact that our wealthy people send East for their furniture. The largest jobs have always gone East. There was $60,000 worth of carving done here for the Hopkins house; but that was not half the value of the carving for the house. Stanford's, Flood's, and Crocker's houses were furnished from the East. On ordinary work of the trade, State Prison labor comes in competition.

CHAS. G. RODANER, 2525 Bryant Street.

CITY LABORERS.

Mr. J. H. Gilmore, 102 Kearny Street, a member of this committee, on applying to a Laborers' Union for information in regard to the condition of labor, received an official reply to the effect that in a Union comprising three hundred members the average amount of work they were able to obtain, taking the year through, was three days per week.

In presiding over a society, and calling the roll to ascertain the number of unemployed members, Mr. Gilmore found that nearly one third were in the country looking for work.

D. McCarty, grainer, 456 Tehama Street, reports to Mr. Gilmore that there are a large number of unemployed workmen in his trade.

Car drivers report sixteen hours work per day for $2 25, and multitudes of applicants willing to work for nothing till they can get an appointment.

BRICKLAYERS.

Rate of wages paid per diem, $4 to $5; per month, $45 to $75; per year, $500 to $650. This branch of industry is one of the best paid per diem. But after a thorough local canvass of the actual condition of the craft, we find the supply of labor to be one third in excess of the demand. Two hundred and forty bricklayers in the city; fifteen hundred per day average bricks; five months in the year out of twelve—five twelfths time average; forty-five million bricks used; nine hours per day constitute a day's work. Molders—Six hundred in the city; $2 50 to $3 50 per day; two thirds unemployed.

CHAPTER VII.

CONVICT LABOR.

Before commencing the transcript of the evidence taken before me upon the momentous question of convict labor, I am convinced that it would not be a waste of time to devote a few lines in reviewing what has been done by the Legislature in the matter.

In Article 10 of the new Constitution, ratified by a vote of the people on the seventh day of May, 1879, Section 6 provided that: "After the first day of January, 1882, the labor of convicts shall not be let out by contract to any person, copartnership, company, or corporation, and the Legislature shall by law provide for the working of convicts for the benefit of the State."

In consonance with this section of the Constitution, an Act was passed at the legislative session of 1880, entitled "An Act to define, regulate, and govern the State Prisons of California." Section 25 of that Act simply followed the dictation of the constitutional provision, but even at the risk of repetition it may be given:

Section 25. After the first day of January, 1882, the labor of convicts shall not be let out by contract to any person, copartnership, company, or corporation by the State Board of Prison Directors, nor shall they let out any such labor prior to January 1, 1882, by contract extending beyond such date; *provided,* that after the passage of this Act, no skilled convict labor shall be let or contracted out at a price less than one dollar per day for each convict; *provided further,* that this section shall not apply to contracts heretofore entered into.

Only one other section of the Act in question referred to the labor of convicts. It ran as follows:

Section 21. All convicts not employed on contracts may be employed by authority of the Board of Directors, under charge of the Wardens and such skilled foremen as he may deem necessary in the performance of work for the State, or in the manufacture of any article or articles which, in the opinion of the Board, may inure to the best interests of the State; and the Board of Directors are hereby authorized to purchase, from time to time, such tools, machinery, and materials, and to direct the employment of such skilled foremen as may be necessary to carry out the provisions of this section, and to dispose of the articles manufactured and not needed by the State, for cash, at public auction, or otherwise. If by auction, after having first given notice of such sale by advertising the time and place thereof, together with a list of the articles to be sold, in ten consecutive issues of two or more daily newspapers of general circulation published in the City and County of San Francisco. The money received from the sale of all articles so sold shall be paid into the State Treasury by the Warden of the Prison, to the credit of the fund of said prison.

Lastly, a portion of Section 23 referred to the matter in the following language:

A Board of State Prison Directors of this State shall require of every able-bodied convict confined in a State Prison as many hours of faithful labor, in each and every day during his term of imprisonment, as shall be prescribed by the rules and regulations of the prison.

The above extracts make up the total of the legislative provisions concerning convict labor, and with all deference to the framers of the law, it must be confessed that it only furnishes an indication of what should be done, and it has been found—as the subjoined testimony will show—very malleable material in the hands of a few interested parties. There can be no doubt that it was the intention of those who put the new Constitution together, and of those who legislated upon it, to abolish convict contract labor, and to establish something better in its stead. There can be no doubt, either, that this result has not been attained, and that the old evils have been perpetuated, although under a new name. That the following pages will fully prove this, I am confident. Such deductions and recommendations as are to be drawn and made must, however, be presented later on, and I shall close these prefatory remarks by quoting the subdivision of Section 3 of the "Act to support and establish a Bureau of Labor Statistics," which empowers me, as its Commissioner, to gather and present the information here given. The words of the Act run as follows:

Section 3. The duties of the Commissioner shall be to collect, assort, systematize, and present * * * statistical details relating to * * *

Eleventh—The number, condition, and nature of the employment of the inmates of the State Prison, and to what extent their employment comes in competition with the labor of mechanics, artisans, and laborers outside of these institutions.

Just prior to entering upon the investigation, I thought it well to secure the opinion of the Attorney-General upon the subject of convict labor, and accordingly wrote him, the following correspondence being the result:

Office of the State Bureau of Labor Statistics, San Francisco, March 14, 1884.

Honorable Ed. Marshall, Attorney-General, State of California:

Dear Sir: In compliance with the request of Hon. Jno. P. Dunn, State Controller, we forward to you copies of the propositions of J. C. Johnson and Company, and the California Furniture Manufacturing Company, accepted by the Board of State Prison Directors February 26, 1884. It is the immediate purpose of this office to institute an investigation into the contract system entered into between the Board of State Prison Directors and any and all parties for the use of convict labor. This investigation will be prosecuted under authority of an "Act establishing a Bureau of Labor Statistics," approved March 3, 1883. Any other information we may possess is at your disposal.

Yours respectfully,

JOHN S. ENOS, Commissioner.

Office of the State Bureau of Labor Statistics, San Francisco, March 25, 1884.

Hon. E. C. Marshall, Attorney-General of California:

Dear Sir: On March 14, 1884, I had forwarded to your address copies of what is supposed to be contracts entered into between the State Board of Prison Directors and J. C. Johnson and Company, and also the California Furniture Manufacturing Company, which was accepted by them February 26, 1884. Will you be kind enough to forward to this office an opinion, as Attorney-General of this State, as to the legality of the action of the State Board of Prison Directors in accepting the propositions of the parties aforementioned. I most respectfully call your attention to Section 6, Article X, of the Constitution; also, to Sections 21 and 25, of "An Act to define, regulate, and govern the State Prisons of California," approved April 15, 1880.

Yours respectfully,

JOHN S. ENOS, Commissioner.

Office of the Attorney-General of the State of California,
Sacramento, March 27, 1884.

Hon. John S. Enos:

Dear Sir: Your favor of the twenty-fifth instant received. Instead of the opinion which you desire, I will furnish you with a copy of a letter I addressed to the Board of State Prison

Directors. This, I cannot do, however, before Saturday next, since the copy is in my office at San Francisco.

Hoping this will be agreeable to you, I am very truly yours,

E. C. MARSHALL, Attorney-General.

OFFICE OF THE ATTORNEY-GENERAL OF THE STATE OF CALIFORNIA,
SAN FRANCISCO, March 14, 1884.

Hon. John Boggs, President of the Board of State Prison Directors:

DEAR SIR: A committee from the "Knights of Labor" and several employés of important industries have represented to this office that a policy is being pursued by the Board which is not merely unfriendly to them, but already seriously injurious, and clearly in violation of the spirit of the Constitution and the policy of the Democratic party. It is stated that contracts are made with manufacturing and other firms in the City of San Francisco, by which material is furnished to the prison to be worked up by convict labor and the finished product returned to the contractors, at a price agreed upon, without competition. This must, to some extent, and does, I am assured by workmen, to a very disastrous extent, affect the labor market in those articles so produced, and gives control of wages to those controlling the convict labor. It is, in fact, as they allege, a persistence in the old contract system prohibited by the new Constitution. You will remember that one (and a grave one) of the charges brought against your predecessors in office was precisely this policy, the only difference being that under the old Board the machinery was furnished by the contractors as well as the material. Now, I understand the practice at present is in effect the same as the old and open to the same objections. In the policy of the State, as to penal institutions, the *profit* on convict labor is the last matter considered. First, the safety of the people; second, the reformation of the criminal; and last and incidentally, the profitable application of the labor involved in carrying out the primary objects of all penal legislation. I understand the purpose of Section 6, of Article X, of the Constitution, to be to prevent competition between convict and free labor, and that the Legislature is charged with the duty of providing for "convict labor for the benefit of the State," subject always to the principle above stated. Doubtless the attention of the Legislature will be called to this subject at an early day. It is at present badly or not at all regulated, but the Constitution is itself clearly prohibitory of the course now being pursued, and enlightened humanity recoils at the enormity of competition (already amounting to disguised war between *free* laborers) being exasperated by the introduction of convict labor. It is a blind and vile economy, and every dollar of profit realized from convict labor at the expense of employment or lower wages to the free laborer is, when thoughtfully considered, a hundredfold loss to civilization. I understand in the shop of Main & Winchester a very serious reduction of men employed has taken place and wages are threatened. The California Manufacturing Company and J. P. Johnson & Co., and, as I am informed, many others, are seeking contracts which I cannot but look upon as direct infringements of Section 6, of Article X, of the Constitution.

I beg to hear from you on this subject, and sincerely hoping that there may be no irreconcilable difference of opinion upon a question of growing importance, I am, respectfully,

E. C. MARSHALL, Attorney-General.

It is presumed there was a reply by Mr. Boggs to this letter of Mr. Marshall, but it has never come into my possession, nor is it pertinent here, since the object of the correspondence is but to show how the Attorney-General stood on the question.

On the twenty-sixth of March, 1884, some fifty subpœnas having been served on all those who were supposed to be able to furnish the requisite information upon the matter to be inquired into, the investigation was commenced in the bureau rooms by the delivery of the following opening statement made by the Commissioner, Mr. Enos:

MR. ENOS: Under Section 3, Subdivision 11, of an Act to support and establish a Bureau of Labor Statistics, it is made the duty of the Commissioner of this bureau to ascertain the number, condition, and nature of the employments of the inmates of the State Prisons, county jails, and reformatory institutions, and to what extent their employment comes in competition with the labor of mechanics, artisans, and laborers, outside of these institutions. That is one of the duties assigned to this office, which it becomes my duty to investigate, and by virtue of that provision in the law, I am now commencing my examination on that subject. Under Article X, Section 6, of the Constitution of this State, after the first day of January, 1882, the labor of convicts shall not be let by contract to any person, copartnership, company, or corporation, and the Legislature shall by law provide for the working of convicts for the benefit of the State. Now, under that provision of the Constitution, the Legislature, by an Act to define, regulate, and govern the State Prisons of California, approved April 15, 1880, passed a law, of which Section 21, Section

23, and Section 25, bear upon that subject. [Reads Sections 21, 23, and 25.] Those are the sections that bear upon this question. Now, we notified the State Prison authorities of San Quentin to furnish us copies of proposals which they have entered into or which they have entertained, with different manufacturing establishments. They have furnished this office with two copies, and I take it for granted those are only two of the contracts, and we have written for further information. One is a contract, or a proposal, whatever they may call it, which is made by the California Furniture Manufacturing Company. [Reads copy of contract with the California Furniture Company.] They furnished us that, and then they furnished us also a proposition—copy of proposition made to J. C. Johnson & Co., in relation to the tanning of hides. [Reads proposition made to J. C. Johnson & Co.] Now I make this statement to show what has been done for the purpose of instituting this investigation, and I will say, briefly, that I am anxious to hear both sides; that this question has been thoroughly ventilated in many of the Eastern States—New Jersey, Ohio, New York, and most of the Eastern States; for instance, in Massachusetts, as early as 1878, the Legislature passed a resolution, which is as follows, upon this question: [Reads.]

"*Resolved,* That the Bureau of Statistics of Labor is hereby authorized to make a full investigation as to the kind and amount of work performed at the penal institutions of this State, and as to all facts pertaining to the same, and to recommend such legislation as is advisable, to prevent competition between said labor and other industries of this State, and report the same to the next General Assembly."

In New York the question of convict labor was agitated by the people, so much so that the Legislature submitted to the people last Fall whether they would do away with convict labor, and on a vote of 673,000—the largest vote ever cast for an amendment—they gave a majority of 138,000 for the abolition of contracting convict labor. So it is no new question, and it is one, I think, very properly we should investigate.

The testimony was all taken in shorthand, and when written out proved to be such a mass of matter that if printed in full it would make a volume almost equaling in bulk a fat "Congressional Record." Accordingly, I have gone all over it again and prepared in most cases synopses, which even now will be found to fill many pages. The sessions, too, were interrupted, and the witnesses represented divers industries, so that it has also been necessary to segregate these under the following heads: Leather, harness, and saddlery, etc.; furniture; door, sash, and window blinds; stonecutting, brick-making, and jute and bagging, in which order the subjects will be presented:

LEATHER, HARNESS, AND SADDLERY.

Patrick F. Robinson testified that he has been a resident of San Francisco for seven years, is a collar and harness maker, and has worked at the business twenty-eight years, having served an apprenticeship. Have worked for Main & Winchester, and also with the firm of J. C. Johnson & Company, but have now a business of my own. When he came to this State first he went in the employ of Mr. Johnson, whose business was on Jackson Street. They had some Chinese at work in the collar department with me; they were working on Boston team collars. At this time Mr. Stone had the contract of the prison labor, and Mr. Johnson thought that prison labor was far cheaper than manufacturing in Jackson Street, and so he quit the business on Jackson Street. At that time Mike Sennet, Thos. Gregory, and I, were thrown out of employment, and I was eleven weeks out of employment through prison labor, and had a family of seven to support. After eleven weeks I got work with Main & Winchester, and worked there until I started a business of my own. But the fact is, we can't compete with prison labor. Mr. Johnson took a contract with the State Prison authorities about four or five years ago and had it until the new Constitution came in force. That convict labor in the State of California is bad for the harness business chiefly. He has to buy convict made collars because he can buy them cheaper than he can manufacture them. In my opinion for Boston team collars was paid fifteen dollars for a dozen in the East. I believe they make them here with convict labor for five dollars a dozen, or even less. I suppose they make them far cheaper here, and they have to try and compete with the State Prison labor. Ninety prisoners working on collars would supply the collar market of California.

William Davis, a saddler doing business in San Francisco seven years, testified as follows: That convict labor is demoralizing to young people that are trying to learn the trade. Have between fifteen and twenty apprentice boys learning the trade. The apprentices get discouraged at the prospect of competing with prison labor. We are compelled to cut down the price of labor by reason of convict work being employed in our business. Convict labor interferes with my trade from fifteen to twenty per cent less than a fair profit. It affects the laborers' wages directly; we have to cut their wages down in proportion to the prices we are getting; $3 to $3 50 is a fair day's wages for collar-makers. Competition with convict labor in my business has compelled me to discharge men and employ boys, or else Chinamen. Convict labor in my business has lessened the price of mechanics' wages from twenty to twenty-five per cent. It drives skilled mechanics out of the business, and deters the young from learning the trade. The convicts employed can furnish the State with all the collars required, if they let half the force loose on collars.

Cal. Ewing, a collar-maker, and a resident of San Francisco, testified as follows: Served an apprenticeship to learn my trade; am now foreman in Main & Winchester's, one of the largest manufactories of harness and collars in the State of California. The wages of collar-makers are not within forty per cent of what they should be, or what they would be were it not for the production of that class of goods by convict labor. The employment of convict labor in our business has cut down wages forty per cent. Mechanics cannot live and support their families and compete with convict labor. I think that fifty per cent of the collar-makers and thirty per cent of the harness-makers are idle through the competition of convict labor. In our business good mechanics should receive from $3 50 to $4 per day. I have been District Master Workman of the Knights of Labor. A mechanic should receive $1 for making a good collar. He can make from $3 to $4 a day.

Malachi Kean, foreman of saddle and harness department in Main & Winchester's for eighteen years, testified as follows: Convict labor has depreciated the price of collars thirty or forty per cent. If convict labor was not employed in the collar and harness business the demand for skilled laborers would be increased. I believe that convicts could more profitably be employed in working the stone quarries of the State, and not putting them to work at mechanical trades.

Jacob C. Johnson, a resident of San Francisco, testified as follows: Am in the saddlery and harness business, and have been in that business, in this city, for thirty-one and one half years. We have at present forty men in our employ, but we are running rather light now on account of general depression in business. Convict labor in my business does not make much difference to the trade. I think aside from the jute business the number of prisoners engaged in manufacturing would be like a drop of water in the Bay of San Francisco. We are having work done by prison labor. The prison authorities requested us to make them a proposition what we would give them to make these different articles mentioned in the accompanying proposition:

San Quentin, January 7, 1884.

Gregory P. Hart, Esq.:

Dear Sir: Messrs. J. C. Johnson & Company requested me to inform you that should his proposition with regard to the collar and harness department be acceptable to the Warden, he will stock the tannery with hides and material for tanning them at the following price for tanning and finishing with convict labor, he paying for free labor: Collar leather, 28 cents per side; alum leather, 25 cents per side; skirting, 34 cents per side; harness leather, 46 cents per side; putting pickled sheep skins through gambier, $1 per 100.

Yours respectfully,

D. SUTHERLAND.

They are making goods for us according to the annexed proposition. Some of the goods made by prison labor are just as good as those made by free skilled labor, and some are not; we have to sell them at a discount, because they are not perfect, and the result is that the labor costs fully as much as free labor. I believe it would be foolish to maintain convicts in idleness. I would like to see them digging down Telegraph Hill. We don't hire our skilled free laborers less than $2 50 or $3 per day, and a good many of our men are making $4 per day; some $3 50; and the ordinary mechanic $2 50 per day. In New York and New Jersey the harness and collar-makers earn from $2 to $2 10 per day. A mechanic making "Boston team collars," at $7 24, can make $15 per week, working ten hours per day. A fair compensation for a mechanic per day is $2 50 to $3.

J. H. Wilson, a resident of California since 1850, testified as follows: Am a harness maker, formerly in the collar business. Convict labor employed in making collars and harness has a depressing effect upon the business. Prison work is not as good as free labor. I am now paying $6 for making a set of harness; in 1875 paid $7 50. A fair price for free labor in making "Boston team collars" is $7 50 per dozen. A fair price for skilled labor in the harness business is $3 per day.

William W. Main testified that he is Superintendent of Main & Winchester's saddle-tree factory. Have been engaged in the business, on and off, for the past thirty years. Have been working for Main & Winchester, and have had a business of my own. Convict labor, in making harnesses, saddles, and collars, keeps a great many young men and boys out of employment; there being no show for competing with convict labor. We pay our mechanics from $2 25 to $2 50 per day in the collar business. I would put the convicts at work in the stone quarries for the State.

Joseph P. Mehn, a collar maker since 1872, testified as follows: Served as an apprentice in learning the trade. For making Boston team collars we get 62½ cents apiece or $7 a dozen—that is for stuffing—and $13 a dozen is what it should be. To take leather and make it up into collars is worth $13 a dozen. A fair price for Boston team collars made by free labor is $32 to $33 per dozen. The collars made by convict labor are sold for $24 per dozen. Owing to convict labor in this business, I have been deprived of work for three seasons. Wages have been cut down from twenty to twenty-five per cent. Manufacturers of harness and collars made by free labor cannot compete with the manufacture of harness and collars made by convict labor. I would not employ the convicts to compete with the mechanics who are good citizens.

John R. Brown resides at Benicia; business, tanning for the last eighteen years; employ between thirty and forty men. Convict labor employed in tanning leather interferes with our business, and cuts the prices down from thirty-three to fifty per cent. The following comparisons of cost will show the injurious effects of convict labor upon the free labor employed in tanning leather. The cost of free labor per side for tanning skirting leather is 71 cents, which includes insurance, taxes, and repairs in the business. The work is done by convict labor for 34 cents per side. The cost of labor for making collar leather is 51 cents per side; add insurance, taxes, and repairs, 20 cents more, making a total of 71 cents. It costs the contractor 28 cents per side when labor is performed by convicts. Labor on alum tanned leather per side, 35 cents. Add to the above 35 cents 17 cents for taxes, insurance, and repairs, and you have the actual cost per side, 52 cents. Cost per side by convict labor, 25 cents. Cost per side for tanning harness leather, 66 cents. Add expenses for insurance, interest, taxes, and repairs, 20 cents, and you have the actual cost per side, 86 cents; the same work costing the contractors, when performed by convicts, 46 cents per side.

James R. Russell, a tanner doing business in San Francisco, testified that the wages of a tanner is low enough as it is, being $15 to $18 per week, and that he would not be able to compete with convict labor any more than with Chinese. He thought that the proper field for convict labor was a farm, on which the State prisoners could raise enough to support themselves and perform a class of work that would not interfere with free labor; the land to be set apart by the State. He thought there was quite *enough* competition among tanners without the prison entering as a competitor, and was sure that convict labor unnecessarily lowered the price of goods.

William Cosbie, a harness and collar maker doing business in San Francisco for twenty-one years, testified as follows: In 1863 skilled mechanics were making $3 to $5 per day at my trade. At that time "Boston team collars" were sold from $36 to $42 per dozen; they are now selling the same collar for $20 to $24 per dozen. I was compelled to abandon the making of collars owing to the competition of Chinese and convict labor. No manufacturer who employs free skilled labor at fair living wages can compete with one whose goods are manufactured by prison labor. The convicts should be worked by the State upon State work, such as building wharves; getting out stone from quarries. Their work should not conflict with the mechanical industries of the State. Harness makers receive $2 to $2 50 per day.

Frank McAleer, a tanner doing business in San Francisco for sixteen years, testified as follows: Employ sometimes twenty men; convict labor in tanning leather is injurious to the business. The State furnishes buildings, water, etc., that we have to pay for. The leather manufactured by prison labor is inferior in quality and the manufacture of the same lowers the wages of free white labor, and the outside manufacturers are not able to carry on the business so extensively, and it also throws out of employment a great many skilled white laborers. A good mechanic in our business should receive $3 per day; convict labor receives from 40 to 50 cents per day. We cannot make the goods for the same price as those made by prison labor. Collar leather is tanned by prison labor for 28 cents per side; it costs me over 60 cents per side. Alum leather is tanned per side by convict labor for 25 cents; it costs me 60 cents. Harness leather is tanned for 46 cents per side by convict labor; it costs me 70 cents per side. Convicts should not be employed in mechanical pursuits to the detriment of the free white laborer. The employment of three hundred or four hundred convicts in tanning leather would produce one half of all the leather tanned in this State.

John S. Wilson, a saddle and harness maker, doing business in San Francisco for fifteen years, testified as follows: Have been in the employ of Main & Winchester, and now in the employ of J. C. Johnson. Prison labor engaged in making harness comes in competition with the outside manufacturers twenty-five per cent. I mean to say it lowers the price of free labor twenty-five per cent. Mechanics in our business should receive $3 per day. A great many are now working for $2, and some are out of employment.

Austin Joseph O'Malley, a harness and collar maker, doing business in San Francisco, testified as follows: Worked at San Quentin Prison for Mr. Stone (from 1877 to 1880) as foreman of the collar and harness department, and then I was employed by the State, in the same capacity, until the second of February of the present year. I had about forty men in my employ then. The work was done under the contract system, and the State was receiving 50 cents a day for the convict labor. These forty men were employed about a year. After that, Mr. Stone, through my persuasions, withdrew the harness business from there, and reduced the force to about twenty-two men, owing to the inferior make of the harness. This was the cause of the withdrawal of the harness business from there. Convict labor in the manufacture of collars and harnesses is demoralizing to the outside trade, to some extent. Goods manufactured by free labor cannot compete with goods manufactured by convict labor. My remedy for convict labor competition would be, to have monthly sales, and sell the goods to the highest bidder at auction. I think this would have the effect to raise the price of goods, so that free labor would get fair compensation in competing with convict labor. All the work in the harness and collar business is done by hand, as hand work is better. When I was foreman I had exclusive charge of that branch of business (that is, the collar and harness department), and gave directions to the convicts; and also received orders from the Warden. Not one in a hundred of the convicts at San Quentin are good mechanics.

FURNITURE.

Nathaniel P. Cole, thirty-two years in the furniture business, testified that he was the President of the California Furniture Manufacturing Company, and that his company's connection with the State Prison labor of this State dated back to a contract in 1871, when Haight was Governor of the State, having worked 200 men in San Quentin on the first of January of that year, and running them up to the fire of February, 1876. The first contract was for six years, expiring in 1877, the fire leaving them with ten months yet to run. Temporary buildings were constructed, 100 men put to work until the mill was up, when a new contract was entered into with Governor Irwin. The terms of both contracts was that the company should pay the convicts forty cents a day, the company putting in the machinery and the State supplying the motive power, including engine, shafting, and pulleys. The second contract expired during Governor Perkins' administration. At its expiration no new contract was had, and the law of April 15, 1880, which provided that no skilled convict labor should be let out for less than $1 per day, Mr. Cole testified he took this to mean men who had worked one year, and on pressure admitted that out of all the men employed there were "probably" about twenty whom he considered to come under the $1 per diem head. From a conversation with Judge Ames, Mr. Cole gathered that the law would be construed favorably to the company, and he put in lumber again and went along under that expectation. The Directors, however, made a demand for the $1 a day payment, and rather than do this the company sold the State the machinery, selling it on the lease, the State to pay it off in rent instead of making a regular purchase. The company then stopped the mill at the request of the Directors, and on the first of January, 1882, inventoried everything and charged it to the State. The State commenced making goods, took orders where they had the opportunity, says Mr. Cole, but substantially the California Furniture Manufacturing Company took the product, paying from three to four thousand dollars a month, less the $500 installment on machinery. This continued until November, 1883, when Mr. Hart (clerk to the Warden) came to him, as the Warden's representative, and asked that a new arrangement might be made. After much talk, the following proposition was made and accepted:

San Francisco, February 20, 1884.

Hon. Paul Shirley, Warden California State Prison, San Quentin:

We hand you herewith the proposition of the California Furniture Manufacturing Company: To take the entire production of one hundred and fifty men and run the furniture department to its fullest capacity, on the following conditions:

1. Inventory the stock on hand and charge the California Furniture Manufacturing Company in memorandum the value of same—valued at cost at San Quentin.

2. Inventory unpaid bills due by furniture department, which the California Manufacturing Company will supply funds to pay, and deduct from total of stock inventory. Not to exceed in amount $2,000.

3. Arrange a schedule of prices per piece, which shall be mutually satisfactory as covering the value of labor of engine, machinery, prisoners, etc.

4. The California Furniture Manufacturing Company to buy all needed stock after date of agreement, and keep the stock account equal in quantity and value to present quantity and value.

5. The California Furniture Manufacturing Company to assume and pay all free labor done in furniture department.

6. The agreement entered into to continue until June 30, 1885, and to continue thereafter if mutually satisfactory. At the termination of the agreement the lumber and material on hand shall be returned to the State of California at cost, and the memorandum account canceled. The State to pay the California Furniture Manufacturing Company any excess in value, if any, over memorandum value, and the California Furniture Manufacturing Company to make good any deficiency, if any, from said value.

7. The California Furniture Manufacturing Company to keep all the machinery and tools in good order and repair, excepting shafting, belting, and pulleys.

8. The State to pay all the over work allowances, provided same are upon agreed tasks.

9. The foreman to be allowed one day each week to visit the city for the purpose of getting orders and purchasing material.

10. The price per piece, set, or dozen, to be arranged to mutual satisfaction on all patterns now made. In fixing value of work on goods, especially ordered, the price shall be arranged by Warden to the satisfaction of California Furniture Manufacturing Company.

11. The California Furniture Company agree, as a condition precedent, that they will take the work of 150 prisoners kept constantly employed, provided that a satisfactory price shall be agreed upon with the Warden for the production of new patterns, price of new patterns to be based on the price of corresponding patterns on agreed list, or to be proportioned relatively.

12. The State and the California Furniture Manufacturing Company shall each furnish a man to take the inventory of material on hand. In case of any disagreement, the two shall call in a third party to decide.

13. After the inventory is made in full, the California Furniture Manufacturing Company to pay the State in cash any balance over the sum nearest total divisable by $5,000.

14. The California Furniture Manufacturing Company to carry insurance up to seventy-five per cent of value on stock, to cover possible loss to State, of the amount of investment on account of State. Policies to be made payable to Paul Shirley, Warden.

15. The California Furniture Manufacturing Company to have control and free use of all machinery, tools, patterns, wagons, sheds, etc., pertaining to the furniture department.

CALIFORNIA FURNITURE MANUFACTURING COMPANY.
By N. P. Cole, President.

That agreement is still in force, although Mr. Cole claimed that he has proposed it should end with the present year. In explanation of the document the witness testified that the company furnished all the material, paid for the labor, and took the product. The two thousand dollars which the company agree to pay was a computation of the debts which the prison had incurred by the purchase of material, and which debt the company assumed when it took the material. The company keeps the stock of lumber intact and pays so much per piece for the articles made. When Mr. Cole's attention was directed to the absence of a schedule of prices he said that none such existed and that the price of the articles was subject to a mutual agreement between the company and the Warden; that is, the company works one hundred and fifty men, takes the product, and pays a mutually satisfactory price. He further testified that the parties to this agreement were the Warden for the State and the foreman for the company. Several questions were put upon this absence of prices, Mr. Cole finally saying that the probability was that the foreman knew all about it. On the subject of the foreman, Mr. Cole's testimony is so involved that it must be reproduced:

Question—Now, who supplies the foremen? Answer—The Warden appoints the foremen, and the State pays them, but come to us for the funds at the end of the month for what they pay for free men.

Q.—Your foreman then pays for the free labor? A.—Eventually; yes, sir.

Q.—Who controls the men? A.—What men?

Q.—Who controls the 200 or 150 men that do this work; who controls them when they are working; who oversees? A.—The appointment is to be by the Warden.

Q.—Under whose supervision and control is this work done—your company or the State? A.—Well, that is a question.

Q.—In other words, the direct supervision is subjected to the examination of a foreman? A.—Yes, sir.

Q.—And he is in your employment? A.—We pay him.

Q.—You pay the money? A.—We pay the money virtually.

Q.—Do you select—is it at your company's suggestion that the foreman is put in charge? A.—Yes, sir. I tell you frankly, that I wouldn't run that one moment without I could have that much control of it.

Upon the question of how much the State received per man under this arrangement Mr. Cole had nothing to say. The character of the work done by the convicts, as compared with that done by free labor, Mr. Cole said was equally good up to a certain point, but only medium and cheap work was attempted. He claimed, too, that the work done by the convicts merely supplemented the imported goods, and that the company was paying a good deal more for free than for convict labor. As to the amount done, the company estimated that the product from two hundred convicts was equivalent to that of seventy-five free men. This he took it to be because the prison could never manage as closely as an individual, and he doubted if the State could ever make the prison self-supporting. Mr. Cole's idea was that the best plan would be to turn the prison into a vast chair-making establishment, since he thought that there was a market and the only competition would be with the East. The general average of wages paid by the company was $3 per day for skilled men and $2 50 to porters. The number of furniture makers on the coast he put down at three thousand.

E. H. Kittredge testified as follows: Am a manufacturer of sash, doors, and blinds, etc., and am connected with the California Sash, Door, and Blind Company, doing business in San Francisco for eight years. Have a contract with the State Prison authorities to work convicts in manufacturing sash, doors, blinds, etc., since January, 1881, or 1882. Prior to that we employed the prisoners and paid the State per day 50 cents, we furnishing the machinery and materials, and employed about two hundred convicts. This continued until the new Constitution went into effect; then we entered into another agreement with the Board of Prison Directors, by which we were to furnish the material and machinery and the State made our goods for so much a piece. The State pays the foreman, whom we selected when first we had work done by prison labor, and they have kept him ever since. The convicts are under his supervision. In my branch of business, I don't think convict labor affects the price of free labor. The goods manufactured by convict labor is as good as that made by free labor, all being done by machinery. Two thirds of all our goods are made by convict labor. We pay the State about $4,000 a month. Mechanics in our business should receive at least $2 25 to $2 50 per day. Under the present system, convict labor is about 40 to 50 cents per day. I know of no Chinese being employed in our branch of business.

Henry Ricke, a cabinet maker, testified as follows: Served three years as an apprentice in Germany. Worked at my trade for twenty-one years. Have carried on the business, but most of the time have been employed. I was foreman over the convicts at San Quentin for N. P. Cole & Co. in the manufacture of furniture. They worked about two hundred and fifty convicts. The competition of convict labor with the mechanics and the industries of the State is detrimental. It has reduced the price of free labor about one half. The price formerly paid to cabinet makers in this State was $3 to $4 per day; the wages at present are from 40 to 50 per cent less, and then not steady employment. If it were not for the competition of convict labor in my branch of business, two thirds of the mechanics now out of employment would be employed. The wages received for convict labor is from 40 to 50 cents per day. Mechanics in my business should receive from $3 to $4 per day. There are a good many cabinet makers thrown out of employment owing to convict labor. Would not work convicts in any branch of business in which skilled labor is employed.

Edward Riley, a collar maker since 1868, testified as follows: Served three years as an apprentice, and have worked at my trade for twenty years in San Francisco. Wages were formerly $3 50 per day, now they average $2 50 per day. Ten hours constitute a day's work. A large number of collar makers are out of employment, owing to the competition of convict labor in our business. Convict labor has injured our business thirty to forty per cent. I have seen collars made by convicts sold at $15 per dozen. The same work made by free mechanics should be sold from $27 to $30 per dozen. The State should work the convicts at manual labor, and the price paid upon the goods manufactured should be the same as it costs free labor to manufacture them.

L. C. Granpner, being called, testified as follows:

By Mr. Enos: Your name, residence, and business? Answer—L. C. Granpner, Red Bluff, California, manufacturer of sash, doors, blinds, etc.

Q.—How long have you been in the business? A.—Fifteen years.

Q.—How many hands do you employ? A.—One hundred and twenty-five maximum and seventy minimum.

Q.—What do you pay for skilled labor? A.—From $2 75 to $4 per day.

Q.—What are the wages of boys and cheap labor? A.—$0 75 to $2 75 per day.

Q.—What were the productions in your factory in 1883? A.—Doors, 64,209; sash, 40,028; blinds, 3,863; and transoms, 5,727. If a man brought lumber to me as they do in State Prisons, each door would be ready for market at a cost of 55 cents, all the labor on the door, sashes 10 and 11 cents, blinds 50 cents, transoms 7 cents. Their maximum 55 cents, my average 55 cents, my minimum 30 cents, theirs 20 cents. The effect of convict labor gives the State or contractor such an advantage as to crush out private enterprise. Cannot compete with the contractors. Manufacturers generally agree as to a fair price for goods they manufacture. Convict labor has cut down prices to such an extent that we don't know what the future may bring forth. Believe that there are three hundred convicts employed in my business within the prison. Such a number of convicts would produce, actually, twenty-five per cent of all the doors manufactured in the State. A skilled mechanic should receive at least $2 50 per day. Any system calculated to reduce such a price necessarily becomes a detriment to the mechanics of the State. Convicts should be employed, but not in mechanical pursuits. No convict learns a trade in prison. He simply becomes a machine himself. He may be in the peg department of the shoe department. He simply learns all about the pegs, but knows nothing at all about the shoe. I believe that nobody, only the contractor, or those who secure the products of their labor at reduced rates, enjoys the benefit of it, and that on the basis of reformation he is not any better prepared to enter the social circle than before he entered prison. I think that they might be employed in making brick, as that industry is now controlled by the Chinese almost exclusively. I believe they should be kept at work, but I don't know what to suggest to make them better men. I think that the present action of the State Board of Prison Directors is as fully as detrimental to free labor as obtained under the past system of the old Constitution. There is no difference. It is just as detrimental to the industries of the State at present as ever it has been in the past.

STONE AND BRICK WORK.

Michael Heverin, a stone contractor, doing business in San Francisco for thirty-two years, testified as follows: My business includes marble, granite, and freestone. Wages paid in my business is $3 50 to $4 per day. For the last ten years it has been about $4 per day. Hours work per day, nine; some work their men ten hours. I have worked as high as forty men. There are between one hundred and fifty and two hundred men employed in cutting stone—that is dressing stone for building purposes. Convicts employed in dressing stone injures our business. It would take twenty to twenty-five men to do the work that was done on the wall around Mr. Fair's lot, about six months. That work was done by convict labor, and has deprived twenty skilled mechanics of employment. If three hundred men should be employed in our prisons in getting out building stone, they would do nearly all, if not all the work required in the State, and deprive stonecutters of employment. A mechanic in our business should receive $3 per day to support his family. If the State received the same pay for convict labor as we pay free labor, it would be better for our business. The output of convict labor should be stamped as being the product of convict labor. I think that the State itself should furnish the material, do all the work, and when the goods are manufactured, offer them for public sale, say once in two months. I think the law should regulate that the State Prison should not contract for any output of convict labor for more than a certain percentage less than free labor could make it. I am not in favor of employing convicts in making blocks unless they get the same price as outsiders. Five hundred convicts employed at quarrying would supply all the demand of the trade by working steady. I conceive it to be the duty of the State authorities, if they manufacture any articles at San Quentin, that they should be manufactured wholly by the

State, for free competition in the market. As the law now is, the State can be a competitor against any industry.

Edmund Dunn, a brick-maker for fourteen years, testified as follows: Am out of the business just now. There are a very few laboring men employed in the business for San Francisco markets; where employed skilled laborers get about $45 per month and board, or about $2 50 per day, for skilled labor, and other common labor about $2 per day. There are four hundred and fifty Chinamen employed in making brick out of five hundred in different parts of the State, making a total of fifty free laborers employed out of five hundred. The Chinese get $1 40 a thousand for making brick—that is, putting them in the kiln ready for burning. The State Prison could employ about four hundred and fifty men in making brick without competing with white labor, if they sold at auction every fourteen days or every month, at their yards (ready to burn), to the dealers here, and put them in kilns of from four hundred to six hundred thousand for each kiln, and would sell these kilns separate to the highest bidder, and that would drive four hundred and fifty Chinamen out of the market.

Gregory P. Hart, clerk of the Warden at San Quentin, stated that the different branches of manufacture at that prison were sash, door, and blinds; general line of furniture; some specific articles; harness, tanning, and jute; boots and shoes, clothing, and tinware—these last being for the use of the prison, as were carpenter, blacksmith, and wheelwright shops, with an occasional use of the brickyards. The method of procedure, he said, was that the contractors or proposers only supplied the material, the State furnishing labor, mode of power, and everything else. In the tannery so much was paid the State per side for the different kinds of leather turned out. These were as follows:

COLLAR LEATHER.

Alum leather	25 cents per side.
Skirting leather	34 cents per side.
Harness leather	46 cents per side.
Putting sheepskins through	$1 per hundred.

These prices are those paid the State by J. C. Johnson & Co., according to an agreement entered into on the first of last February. Upon the schedule of prices paid to the State by the other contractors, Mr. Hart could say nothing, failing to remember anything, except he believed that from 11 to 18 cents were paid for sash and that from 16 to 15 cents were paid per door. In the jute works not less than three hundred men were being worked daily at one hundred looms, and calculating sixty yards a day per loom, he put down the product at six thousand yards of cloth per diem. For this the State could calculate on $7\frac{10}{100}$ cents per yard. The boot and shoe industry was confined to making and repairing for the prisoners.

Taking up another branch of the subject, Mr. Hart testified that, taking everything into account, the cost to the State of keeping the prisoners at San Quentin was from 35 to 40 cents per diem. The average day's work of a prisoner was eight hours, there being little difference Summer and Winter.

He thought the plan of the State manufacturing and offering prison-made goods for sale, as a mercantile corporation, to be impracticable, and even went so far as to give it as his belief that the State would not be able to find purchasers.

Much of the rest of the examination was devoted to a consideration of the question, whether the present system of conducting our State Prisons interferes with discipline; but as that is a side issue, it may be passed over for the present.

Several other witnesses were examined, among them Director Hendricks; but enough has been given to show that the question was fully considered pro and con. Even after the formal examination was closed, informal discussions were held, in which every branch of the subject was ventilated, and its every bearing touched upon.

CONCLUSIONS.

What, then, are the conclusions arrived at? This, in the first place: That the subject is one of the most abstruse and complex in modern legislation. It may be imagined that this is too sweeping a statement, but I am well supported by the following opinions.

In its second biennial report, the Bureau of Labor Statistics of the State of Illinois, in grappling with the question of "Convict Labor," contains the following:

> The employment of the criminals of the State in our two penitentiaries, under contractors, who secure their service at low rates of wages, and thus are enabled to place the products of that labor in the market frequently at ruinously competitive prices, constitutes an injustice alike to the manufacturers and to the honest workingmen of the State, against which they make constant and earnest protest.
>
> It is recognized that on humanitarian, sanitary, and other grounds, occupation of some kind should be given to State prisoners; but it is objected that under the present system the labor of convicts is so contracted as to operate injuriously upon many skilled occupations in civil life, by rendering a reduction in wages necessary to enable employers to compete with penitentiary contractors. The plea urged in support of this system, that it renders our penal institutions nearly or quite self-supporting, is not recognized as either justifying the system or as constituting a permanent desideratum in public policy. The welfare of the industrious and honest citizen is of higher import to the State than any merely economical consideration in administering the affairs of its penal institutions. By the contract system the cost of the criminals of the State is indirectly imposed, in unequal measure, upon those least able to bear it—upon the workingmen themselves, who are compelled to compete with prison labor, in order that the prisons may be made self-supporting.
>
> Among the suggestions urged as partial remedies, at least, for this evil, is the employment of convicts under prison management, the goods manufactured to be sold at market rates, and the profits, if any, to accrue to the prisoners upon their discharge, or to their families during incarceration, or to the State. Another is the employment of convicts, so far as possible, upon public works involving but little skill, as in the manufacture of macadam for a system of public highways. Still another comes from the Warden of the new Southern Penitentiary, who urges that prisoners at that institution be employed in the making of brick and quarrying of stone, for which the opportunities at Chester are specially good, rather than in the more skilled occupations under contractors.

The Michigan State Bureau of Statistics goes even further, and in its last annual report has the following to say:

HOW SHALL THEY BE EMPLOYED?

> The people of this State have embraced in the Constitution this provision:
>
> "No mechanical trade shall hereafter be taught to convicts in the State Prison of this State, except the manufacture of those articles of which the chief supply for home consumption is imported from other States and countries."
>
> Irrespective of the question of the wisdom or unwisdom of such a provision, it is nevertheless a part of the organic law and it is at least questionable whether the State should not submit the question of its propriety to the people before violating the letter and spirit of a constitution which it expects the people to respect.
>
> Concede that they should be employed, yet the object of their employment is not alone pecuniary profit to the State. The mental, moral, and physical condition of the prisoner during his detention and at the time of his discharge, has entered largely into the question of the policy of his employment. The desire to make these institutions in a measure reformatory as well as punitory, and that the State may to some extent be relieved of the burden of the support of criminals, together led to their employment.

The purpose of the detention of a prisoner should never be lost sight of while the detention continues; the short-time prisoners should be subjected to reformatory or educational treatment as well as the long-timer.

If, in thirty days, a convict can be instructed in the alphabet of any industrial art, to which he can turn his energies after his discharge, or if he can be taught that industry is the best policy, he should be so directed, even at a cost to the State.

The manufacturer complains that the articles manufactured in our penal institutions come into competition with goods which he manufactures, and the wage-worker insists that the wage market is being further depressed by convict labor, sold for less than will support the convicts while engaged in it, or its product sold for less than free labor can produce it.

It has occurred to us that these results are felt, because of the contract system, whereby the contractor obtains a great advantage over other manufacturers, and because where the contract system does not prevail, the institution is being carried on with unlimited capital and credit, with large buildings and capacity, without taxes, as a great manufacturing enterprise, where the cost of maintenance is from eleven to nineteen cents per day, and where, for a large percentage of its operatives, it receives pay for their board at a rate which covers, if not exceeds, the expense of their maintenance, and that if the contract system were abolished, and these institutions operated with a view to the reformation of their inmates, as corrective schools, rather than manufactories, treating their labor as labor should be regarded, not only in prison but out of it, as an incident, as a means—not an end—there would be less cause for complaint.

CONTRACT SYSTEM.

The contract system should be abolished, because:

First—The contractor has no interest in the prisoner except in his ability to produce. The prisoner is the ward of the State. His employment is a means, not an end, and no contractor with arbitrary rules as to time, etc., should come between the prisoner and the State. The incentive to labor should be shortened terms, care for dependents, and payment of a stipend when discharged. These men are required to work an average of ten hours per day for the year, eight and one half hours in midwinter, and eleven and one half hours in midsummer, and they work diligently. They haven't the relief incident to outdoor labor—no rainy days—all their time is employed except nights and Sundays. Is it not idle to expect reformatory or educational influences to be exerted, except those incident to industry, or to operate upon men who work ten hours per day? The inmates are tired, the keepers have been with the men all day, and the Warden or Superintendent has been engrossed with the management of the financial and commercial transactions of the prison.

Second—The sale of the product should be regulated by the State.

Third—If there is any profit in his employment it should not go to the contractor. If the contract system is retained, the State should own the plant and machinery as well as the shops, and thus open a wider field for competition.

The annual report for 1882–83 of the "Bureau of Industrial Statistics" of Pennsylvania follows in a similar strain. It first speaks of imported contract labor, charging that large contractors through their agents import pauper labor from Europe, and declares that this is not only rank injustice to the working people of the commonwealth, but that the competition created by the importation of these ignorant and degraded paupers, lowers the social and moral position of the home working man. To the contractor the gain is but for a moment, while the evil to the community is lasting, and the contract system is a blow at the interest of both labor and capital. Applying these remarks to the subject of convict labor the Chief of the Bureau writes as follows:

CONVICT CONTRACT LABOR.

The same objections are urged against the system of convict contract labor in our prisons and penitentiaries, and is a subject which has agitated the minds of the working classes in a number of the leading manufacturing States for a number of years. It has, in fact, the same effect in lowering the standard of wages and depriving the honest workingman of the just reward of his labor, whilst there is not the same appearance of reason to justify it. Two reasons among others have been given in justification of contract labor: 1. The reduction of prison expenses, and the relief from general taxation to that extent; and, 2. The elevation of the criminal by occupying his time in a useful and honorable pursuit; by promoting in him habits of industry, and in so educating him that at the end of his term of imprisonment he will have acquired the habits, knowledge, and disposition which will enable him to earn an honest living. It has been found, however, that the convict contract system tends to degrade not elevate the prisoner. The contractor, holding his labor in contempt, and actuated solely by his own selfish purposes, treats the prisoner as outside the pale of humanity. The direct expense is saved to the State, but the degradation of the prisoner is increased. The practical effect of prison competition has been found to be the production of articles at so small a cost as to defy the competition of honest and law-abiding labor. The standard of honest wages is prejudiced, governed, and controlled by criminal labor. Under the convict contract system capital, which regards labor as a brutal machine, obtains an advantage over capital which employs honest men, and seeks to elevate and benefit the working classes. The evils resulting to the working people by the introduction of the unfair competition of imported pauper labor are the same as from contract convict labor, whilst the objection of such importation is solely a temporary advantage gained by the contractor.

The foregoing extracts afford, I am sure, all the evidence that is needed to convince this honorable body of the extraordinary importance of the subject of convict labor, and if anything further were needed, let me assure you that it forms the major portion of every report made by the other bureaus of labor statistics throughout the country.

APPLICATIONS.

To come now to a local application of the lessons, facts, and figures under consideration. That the law aiming to do away with an evil has not yet been successful, must have been seen by the attentive reader of this chapter. In two words, the case stands thus: Before the Act of 1880 went into operation, which was on the first of January, 1882, a few business firms in San Francisco practically controlled the State Prison at San Quentin by contracting to furnish its convicts with labor at so much a day. This was seen to be wrong, and by the provisions of the Act referred to the contract system was done away with, and in its place the following plan of working the convicts was ordered: That the State should supply the labor and motive power to whosoever wished to engage them, and then that the product should be sold at a reasonable rate.

How has this plan worked? Practically the old contract system is still as active as it ever was, although masquerading under another name. Instead of contracting to pay so much per diem for convict labor, the firms who now make use of a State institution, contract to pay so much for the product of that labor. It is true that the contract is now called a "proposition," but its effects are practically and precisely the same. The result proves this. The evil complained of under the contract labor system was that the firms by paying a low, an exceedingly low rate of wages, were enabled to have made for them articles at such a price that it would be impossible for any other manufacturer who was not enjoying the benefits of such a contract to produce similar goods at anything approaching a similar price. Under the present system, a few firms contract to take from the prison all that is manufactured there at certain prices, but these prices, like the wages they paid, are so low that they once more receive their goods at a rate which again enables them to place them on the market at a figure with which no outside firm can compete. What difference does it make then, whether these firms contract to pay a certain wage, or contract to pay a certain price for the product, when wage and price are both ruinously low? Call it wage per diem, or call it price per piece, the result is precisely the same. It is only a case of evasion, of tweedledum and tweedledee, of upper and lower millstones, between which the poor working man, who is not in State Prison, is being rapidly ground down.

Another question to be considered is: how does the State come out in this case of change without alteration? My opinion is that she is worse off now than she was before; or at any rate the firms doing business at San Quentin have not afforded me an opportunity to disprove this. Under the old system it was known exactly how much the State received; so many convicts were working at so much, with such a result. Under the new system there is such secrecy, such forgetfulness, such lapses of memory, and such mislaying of papers, that it has been found impossible to procure what may be called an official schedule of the prices paid by the contractors to the State Prison for the articles made there. The inquiries pushed concerning this evasive schedule were numerous but unavailing, the written demands for a glimpse of this precious document were many but irresponsive. As a consequence, I cannot present you with exact figures, and am forced to the deduction that the firms who are the patrons of State penal industry must have very good or very bad reasons for their want of confidence. A history of the correspondence between the Warden at San Quentin and this bureau on the one hand, and between the California Furniture Manufacturing Company and myself on the other, would be too tedious to reproduce, and it must suffice to say that it was unproductive. The termination of the correspondence will best show how matters stand. On the thirtieth of September, 1884, the following letter was addressed to the Warden at San Quentin, but before giving it, it should be premised that the "prompt answer," to which reference is made, was in reply to a similar demand, coupled with the request for a classification of the prisoners under his charge. This classification he furnished, but omitted to give the schedule of prices asked for, and then it was that this letter of the thirtieth was written:

Office of State Bureau of Labor Statistics,
San Francisco, September 30, 1884.

Hon. Paul Shirley, Warden San Quentin Prison:

Dear Sir: Your favor dated twenty-seventh at hand, and I wish to express to you my sincere thanks for your prompt reply.

You would oblige me by furnishing this office with *the names of all* persons having work done at the prison, and also *the price-list* of the said work; also, the cost per day to support convicts (food, clothing, etc.); also, the *monthly* output in the different branches of industry in the prison, viz: chair department, jute, etc.

By complying with the above request, you will confer a favor on,

Yours truly,

JOHN S. ENOS, Commissioner.

In answer to the above, the following was received:

Warden's Office, California State Prison,
San Quentin, October 2, 1884.

Hon. John S. Enos, corner Geary and Dupont Streets, San Francisco:

Dear Sir: Your favor of thirtieth ult. is duly at hand and noted. To give you all the data you ask would take some time, and will appear almost as you want it in our annual report, now preparing. Any information you require other than that contained in the report will be promptly furnished.

Yours, very truly,

PAUL SHIRLEY, Warden.

From N. P. Cole there was asked a price list of the goods received by the California Furniture Manufacturing Company from San Quentin; the following being the last response:

California Furniture Manufacturing Company,
San Francisco, September 28, 1884.

John S. Enos, Esq.:

Dear Sir: Yours of this date I received by the hand of one of your clerks, and told him I would send the list to you to-morrow. Since he left, it occurred to me that I had better get the consent of the Warden of the prison before furnishing it. As soon as I get his answer, will attend to it at once. I am perfectly willing to furnish it, and know of no reason that would cause the officers of the prison to object.

I remain yours, truly,

N. P. COLE.

The plain English of this correspondence is that Mr. Cole does not see fit to give the information asked for until after consultation with the Warden—though where the necessity for this consultation comes in you will, perhaps, fail to see—and the Warden refers me to a report which is at present unavailable. How necessary and valuable this information would be you may gather from the statement made by Gregory P. Hart, in his testimony, that, "the prison authorities have a specified price for every article they produce."

So much for the furniture part of the product. Next comes the sash, door, and blind department, the product of which is taken, on propositions by Kittredge & Co., Doe & Co., and Wilson & Bros. The same non-success attended my endeavors to procure the schedule of prices paid by these firms; but, fortunately, I have been enabled to supply its place from an outside source. I refer to the following letter, furnished me by one of the largest manufacturing companies, in a similar line, in the State:

Regarding the disadvantageous relation occupied by manufacturers employing free white skilled labor, in competition with convict labor producing the same articles at California State Prison, the situation can be best illustrated by a statement showing the operations of a single month, and comparing same with the cost of a similar output manufactured by free white labor, men and boys, outside the prison walls. For example, take the ascertained monthly result in the case of California Door Company, occupying nearly one half the prison shops and manufacturing facilities. The State furnishes a brick building 60x200 feet, four stories, with power, shafting, elevators, etc.; also space for piling lumber, drying kilns, and heating facilities. For the month of June the articles turned out at prices opposite each item, were very nearly as follows:

11,500 doors all kinds, average 24 cents	$2,760 00
8,000 pairs 1¼ and 1½ sashes, average 13 cents	1,040 00
1,500 pairs outside blinds, 25 cents	375 00
750 sets inside blinds, 75 cents	562 50
1,000 transoms, 5 cents	50 00
	$4,787 50
State paid for supervising free labor, say	1,300 00
Leaving net amount received for month	$3,487 50
Out of this, take for rent of land occupied by lumber, rent of these immense shops, cost of power, wear and tear, etc., a low estimate would be, per month	700 00
Leaving to the State for convict labor	$2,787 50

Number of convicts employed, estimated on a pro rata basis of other months, would be 295; the amount received by State per convict per day for 26 working days being less than 38 cents each. When it is considered that the State maintains these prisoners at an alleged cost of 44 cents each per day, the money result above shown seems grossly inadequate. These convicts, it is admitted, do good work. They are allowed 10 cents per day each for good performance, in the shape of a fortnightly credit of $1 20 each at commissary's store; supposed to be paid by door company. This "douceur" of 10 cents per day is understood as an *additional* sweetner to California prison life; making the California State Prison all the more fashionable and pleasant as a resort for criminals, small and large. That it is, in that respect, altogether too popular, is evidenced by the very large proportion of our population seeking its fine accommodation; aside from shorter hours, these convicts doubtless produce as much per man as would average hands in similar establishments outside the prison. No comparison can be made with any factory as large, in this State, as none could exist while this remains. It may be safely estimated that the payroll of a similar establishment, working free white men and boys, and making the same monthly output, would be at least three and a half times (for the same work) the amount received by the State, for convict labor, boarded and clothed by the State. Regarding a statement of Warden Shirley made last April, before Hon. Commissioner of California Bureau Labor

Statistics, that "State Prison productions of doors, sash, and blinds was less than one per cent of home consumption," it was then more than one third, and has for several months been more than one half of all the factory products of that line of goods within the State of California.

Concerning the prices paid for the product of the harness and tannery departments not so much difficulty was experienced in gaining the needed figures, although the details are not so full as could be wished for. The prices paid by J. C. Johnson & Co. will be found in Mr. Hart's testimony, while the prices paid the trade are given in the following statement, made by John R. Brown, of Benicia:

Benicia, Cal., March 4, 1884.

To J. S. Enos, Commissioner Labor Bureau:

Cost of labor for making collar leather, per side:

Labor in beam house	$0 15
Labor in tanyard	8
Labor in splitting and shaving	8
Labor in scouring	4
Labor in setting and stuffing	6
Labor in blacking	6
Labor in finishing	4
	$0 51

Add to this insurance, taxes, night watch, engineer, teamsters, incidentals—such as machine oil, all repairs—it will actually make the cost, say—

As enumerated above	51 cents per side.
The added expenses	20 cents per side.
Total	71 cents per side.

These are bedrock prices.

Cost of skirting leather:

For labor in beam house	$0 18
For labor in yard	9
For labor in skiving	6
For labor in scouring	6
For labor in setting and stuffing	8
For labor in finishing	4
	$0 51

Add to this enumerated items in No. 1, and the cost per side will be 71 cents.

For harness leather, per side:

Beam house	$0 18
Yard	9
Shaving	6
Scouring	6
Setting and stuffing	9
Blacking	9
Finishing	9
	$0 66

Add to this expenses as per list No. 1, which must take place on all grades of leather the same, and we find that 86 cents per side is the actual cost of common harness per side, as far as labor is concerned.

Labor on alum-tanned leather, per side:

Beam house	$0 15
Yard	7
Setting and stuffing	5
Finishing	6
Measuring and gum	2
	$0 35
Add to the above	17
	$0 52

Which is the actual cost per side for alum leather.

DEAR SIR: I have this day sent to your office cost of making leather outside the State Prison, at wages ranging from $2 to $2 50 per day. This statement will bear the light of day, as I am willing to submit the prices or cost per side to any three practical tanners of this State.

You will see by this statement that the Prison Commissioners are offering to do the work at ruinously low prices. The State would not get more than board for the men at the rates they work the convicts at San Quentin.

Very respectfully yours,

J. R. BROWN & CO.

The other products, boots and shoes, tinware, and clothing, are made by the convicts for the convicts, and not being put on the market are outside of the scope of this inquiry, while the jute factory, being a State industry, also belongs to another branch.

The following is a statement of the number of prisoners confined in the State Prisons and their various employments:

STATE PRISON AT SAN QUENTIN.

On the first of September, viz.:

Chair department, 103; door department, 191; jute mill, 288; tannery department, 13; harness department, 26; foundry department, 8; engineer department, 15; general kitchen, 45; hospital kitchen, 6; outside kitchen, 15; laundry department, 29; house servants, 37; scavengers, 10; sweepers, 13; whitewashers, 7; tailor shop, 12; shoe shop, 12; cooper shop, 1; paint shop, 5; tin shop, 4; carpenter shop, 3; barber shop, 10; vegetable gardens, 8; flower gardens, 4; chicken ranch, 2; hog ranch, 1; brickyard, 74; Captain of Yard's office, 4; Turnkey's office, 4; Warden's office, 4; Clerk's office, 2; Commissary Department, 7; cell and room tenders, 30; blacksmiths, 6; stables, 18; coal yard, 1; upholsterer, 1; belt maker, 1; "hoodoo" (general work), 40; lumber yard, 9; library, 7; hospital nurses, 2; patients in hospital, 11; door tenders, 6; gate tenders, 8; cripples and imbeciles, 25; dentist, 1; physician's office, 1; females, 13; unemployed, none. Total number of prisoners, 1,143.

STATE PRISON AT FOLSOM.

There are 479 prisoners on the register of the prison at this date. They are employed in the granite quarries in the prison yard, and in the improvement of the prison tract; and also in the various occupations needed for the carrying on of a prison. For the offices and stores, messengers, bed makers, and hospital, 20; invalids or incapables, 15; tailor shop, 6; shoe shop, 2; butcher shop, 1; carpenter shop, 7; tin shop, 3; blacksmith shop, 17; wagon and repair shop, 2; paint shop, 4; plumbers, 2; engineer department, 12; gashouse, stable, woodsawyers, woodcarriers, sweepers, general help in prison, cell tenders, whitewashers, officers' dining room and kitchen, prisoners' dining rooms and kitchens, gardeners, freight handlers, water carriers, lamplighters, teamsters, night cooks, gate tenders, 113; laundry, 12; barbers, rope room, riggers, wood-choppers, ox-drivers, graders, tool carriers, 37; wall builders, 5; stonecutters, 30; rough dressers, 30; derrick men, 20; quarrymen and shovelers, 141. There are none unemployed, except those noted as "invalids or incapables," and these are men who are crippled, or of unsound mind, or convalescing patients. There are but two in the hospital, and one is the nurse. The prisoners labor diligently, and show an interest in their work. Every man who is able to work is employed; the one female prisoner is also employed in the Turnkey's office and as seamstress.

This contract or proposition system not only does an injury to the workingman, but also to manufacturers. The injury to the workingman is that for the making of certain classes of goods a wage is paid that he, on the outside, cannot afford to work for; the injury to the manufacturer is that these goods are produced at a cost which is altogether below that entailed in the ordinary course of production. It is true, as has been seen by the testimony, that the firms who do business with the State Prison furnish the material, pay the skilled labor, that is the foremen and their assistants, pay for freight and hauling, and in one instance, at least, own the machinery, but all these, even for the moment leaving the low prices out of consideration, do not place the non-contracting firms on equal terms with those whose propositions have been accepted. The employers of prison labor pay no rent for warehouses, factories, etc., and have been put to no expense in erecting them; have no insurance to meet; no taxes to pay. It is claimed that the holders of accepted propositions enjoy their privileges in due and legal form; that every effort has been made on the part of the State officials to secure the best prices for the State's product. Whether this has been done or not, is not, I think, for me to judge; at any rate I would prefer that if inquiries and decisions are to be made that they should be made legislative, rather than bureaucratic.

Another question to be taken under consideration is whether the present system is the best financially for the State's interest. In the absence of the State Prison report, before referred to, an exact balance sheet, showing expenditures and receipts, cannot be given. From Mr. Hart's testimony, however, these round figures are gathered: The furniture company pays to the State about $4,000 per month; the sash, door, and blind company about a similar amount. The amount received by the State for the product of the harness and tanning department was not procurable. The figures given are far too general to be of any practical use, and I would suggest to your honorable body "that it would be an interesting inquiry to find out how the expenses and receipts of the State Prisons under the present system of convict labor compare with those of the old."

RECOMMENDATIONS.

Having presented as clear and impartial a statement of the case, *in statu quo*, as possible, I beg now to offer to your honorable body the following recommendations as to the future policy of utilizing convict labor:

First—That the contracts known as "propositions," now in force, shall be annulled.

Second—That if it be decided to give the present system a further trial, that the Wardens of the State Prisons shall immediately cause to be published in two San Francisco daily newspapers, of the largest general circulation, notices of proposals for manufacturing to be carried on in the said prisons, in such branches of industry as to the Wardens and Board of Prison Directors seem best adapted to the discipline of the prisons, and the remunerative employment of the convicts.

Third—That no propsal, so advertised for, shall be accepted, unless under the following conditions:

(a) The party, or corporation, or firm, making such proposal to the State, shall pay such reasonable rent for the use of shops, store room, steam power, and machinery (where the machinery is owned by the State) as are required to carry on such industry as the Wardens and Directors may consider just and proper.

(b) That, when any machinery, not now owned by the State, is needed, the party, corporation, or firm making such proposals, shall agree to put such machinery in place at their own expense; and to remove it without expense to the State, when the time limit of the proposal has expired.

(c) That the said party, corporation, or firm, shall also agree to furnish all other appliances necessary to the industry, and all the raw material used in connection therewith.

(d) That, on their part, the Wardens and Directors shall agree to keep all the machinery, whether owned by the State, or not, in proper repair, and to return to said party, corporation, or firm, whatever machinery may belong to them in as good condition as when received, natural wear and tear and unavoidable accidents excepted.

(e) That the party, corporation, or firm, shall furnish and pay the necessary skilled instructors and foremen, but that these, while so employed, shall be under the control of proper officers of the prisons, and that they shall in no way interfere with the discipline of the convicts.

(f) That monthly settlements shall be made between the Wardens, and such party, corporation, or firm, whose proposal has been accepted.

Fourth—That it shall be the fundamental provision in the transactions, between the State, and party, or firm, or corporation, that these transactions shall be based upon the market price of such articles as form the subject of the proposals; and that, in no case, shall a price be agreed upon that is not a fair market rate, that is not a commensurate return for the State's outlay, or that would allow such party, corporation, or firm, to enter into an unjust competition with the free labor of the State.

Fifth—That rather than such unjust competition should be practiced, or that the State should be made the instrument of an injurious opposition to manufacturers and free men, engaged in similar businesses on the outside, or that a system should be carried on under State control, tending to loss of employment or reduction of wages, the convicts of our State Prisons should serve their terms in idleness.

Sixth—That the maximum number of convicts to be employed in the State Prisons, in any industry, shall not exceed 5 per cent of the number of free mechanics employed in that identical industry in the State; and that in no case shall the product of the convicts, working under these proposals, exceed 5 per cent of the product of the free manufactories engaged in similar industries, except in the case of jute.

Seventh—That the attempt should be made to establish and carry on in the State Prisons such industries as are not already conducted in California; a plan by which all competition with free labor would be at once avoided.

Eighth—That the labor of the convicts be utilized in the manufacture of such goods and articles as the State requires for its different offices, establishments, and institutions; and that the State be a direct and *first hand* customer of the State Prisons industries, instead of buying second hand those goods and articles that are made within its own prison walls.

Ninth—That wherever practicable, convict labor should be employed in the erection, maintenance, pursuit, and repair of State and county institutions, and works.

CHAPTER VIII.

CHINESE LABOR.

It is difficult to overrate the effect and influence of the Chinese upon the industrial condition of our State. At a rough estimate we have about one hundred and four thousand of them here at present. Eighty per cent of that number directly competing with white labor, and the remaining twenty per cent engaged in trading with China and the Chinese, supplying the wants and requirements of the latter, whether of clothing, food, or anything else, almost entirely with Chinese products. It is at this place that I desire to make a suggestion. Why may not Congress be asked to lay heavy import duties upon such Chinese goods as are used by Chinese only? If it is a bad thing for the country that our money should be drawn away to a foreign country without a commercial return, as is done by the Chinese, then a heavy protective tariff on those goods would be just the thing. It would keep at least a portion of that money here. As will be seen by the accompanying table but twenty-five per cent of the food used by the Chinese is of Californian production, the other seventy-five per cent coming from China. In like manner these aliens bring eighty per cent of their clothing from the Flowery Kingdom; and as for drugs, and the other thousand and one things used by Chinese, all these things come from their native land.

Again, a protective tariff of the kind I have referred to would affect the American laborer most beneficially. It would raise the Chinaman's cost of living, thereby causing an increase of his pay, and in that manner the difference between the Mongolian's and the white man's wage would be lessened, and the latter would be the better able to compete with him. In my humble opinion, the matter is worthy of your legislative consideration.

It is not good policy for this State to cease agitating the Chinese question, although popular expression on the subject has recently become less pronounced. The Restriction Act gives us little more than a breathing spell and an opportunity, and unless that opportunity is made use of, ten years hence the portals will open once more to the myriad sons of the Celestial Empire. The State should act vigorously and to the full extent of its power. It is only by deep reflection that the influence of this evil, as it now exists and has existed for years past, can be fully comprehended. Nobody who does not actively and intimately mingle with the industrial classes can judge rightly of the influence for evil of one hundred and four thousand heathen workers, crowding out a like number of heads of families, upon the industrial and political economy of the commonwealth. Their presence keeps away half a million people directly, and another half a million indirectly; it leaves our daughters without husbands and our boys with diminished chances to earn a livelihood; it reduces the wage earning power of all, and, as experience has shown, inflicts irreparable damages even upon those who once encouraged and lived by Chinese labor. Whatever may have been the case heretofore, there is now no longer a necessity for coolie labor in this State, from the wealth of which they take annually about $28,000,000 to send into that sink of all wealth, the Chinese Empire. So much has been written upon the subject of the Chinese, that I feel I may safely leave it with these few remarks. The popular mind on the subject is fully made up, and nothing that I could add would increase the conviction that the Chinese are an unmitigated evil in and to California.

Although, as has been shown in a previous chapter, the replies to the circulars sent to the different County Assessors were not as fully answered as could be wished, enough was received from them and gathered elsewhere to enable me to present the following tables:

RATES OF WAGES PAID TO CHINESE.

Class of Labor.	Wages Paid.			
	Maximum	Minimum	Average	With or Without Board
Domestic servants	$25 00 per month	$18 00 per month	$21 50 per month	With
Cooks	30 00 per month	10 00 per month	20 00 per month	With
Laundrymen	12 00 per month	6 00 per month	10 00 per month	With
Cultivators of soil	30 00 per month	25 00 per month	27 50 per month	With
Farm laborers	25 00 per month	20 00 per month	22 50 per month	With
Brick makers	35 00 per month	25 00 per month	30 00 per month	Without
Slipper makers	5 00 per week	4 00 per week	4 50 per week	Without
Bag makers	6 00 per week	4 50 per week	5 25 per week	Without
Miners	2 00 per day	1 50 per day	1 75 per day	With
In canneries	1 25 per day	75 per day	1 00 per day	Without
Boot and shoe makers	1 75 per day	75 per day	1 25 per day	Without
Cigar makers	$4 to $12 per 1,000			Without
Cigar strippers	Paid by the piece			Without
Fishermen	Nearly all on their	own account		

The above table refers to their receipts. Their expenses are best expressed in the answers attached to the following questions:

COST OF LIVING TO CHINESE.

How much do they expend for rent either per head or collectively per month? $2 to $4.
How much do they expend for food per head or collectively per month? $5.
What percentage of the food are home products? 25 per cent.
What percentage of the food are imported from foreign countries? 75 per cent.
How much do they expend for clothing per head each year? $10 to $12.
What percentage of the clothing is of American manufacture? 20 per cent.
What percentage of the clothing is imported? 80 per cent.
How much of their yearly earnings are sent out of the country? 75 per cent.
What percentage to the amount of earnings? 75 per cent.

Some light may be thrown upon the much debated question of the extent to which the employment of the Chinese comes in competition with the white industrial class, by the presentation of these facts: In 1880, there were 75,132 Chinese in the State of California. In the year ending June 30, 1882, 39,579 Chinese arrived in California. During the year ending June 30, 1883, 8,031 arrived here. Of the 8,031 emigrants arrived from China during the fiscal year 1883, 6,613 arrived during the month of July, 1882, and previous to the date when the Chinese Restriction Act went into effect, viz.: August 6, 1882, leaving but 1,418 arrivals during the remaining eleven months of the year. After making due allowance for the return of the Chinese to their native country, there are 104,000 Chinese in California at present. They are nearly all employed. Their average wages per day, including cooks, employés in wash-houses and manufacturing industries, mining and agricultural laborers, is $1 for ten months in the year, counting twenty-six days per month as "working days." The wages per head would be $260 per annum; 104,000 Chinese at $260 per year, would make a total of $27,040,000, paid the Chinese in California in the year 1884.

The following table shows the proportion of Chinese in other States and Territories where they form a notable element of the population:

States and Territories.	Number of Chinese to 100,000 Whites.
Idaho	11,647
Nevada	10,113
Oregon	5,832
Montana	4,988
Washington	4,741
Wyoming	4,702
Arizona	4,636
Colorado	320

The following table shows the number of Chinese, Japanese, and Indians (out of tribal relations) in each State and Territory. Indians under tribal relations are not included, but are the subject of a special inquiry by the Census Office:

States and Territories.	Chinese.	Japanese.	Indians.
Alabama	4	----------	213
Arizona	1,630	2	3,493
Arkansas	133	----------	195
California	104,000	86	16,277
Colorado	612	----------	154
Connecticut	123	6	255
Dakota	238	----------	1,391
Delaware	1	----------	5
District of Columbia	13	4	5
Florida	18	----------	180
Georgia	17	----------	124
Idaho	3,379	----------	165
Illinois	209	3	140
Indiana	29	----------	246
Iowa	33	----------	466
Kansas	19	----------	815
Kentucky	10	----------	50
Louisiana	489	----------	848
Maine	8	----------	625
Maryland	5	----------	15
Massachusetts	229	8	369
Michigan	27	1	7,249
Minnesota	24	1	2,300
Mississippi	51	----------	1,857
Missouri	91	----------	113
Montana	1,765	----------	1,663
Nebraska	18	----------	235
Nevada	5,416	3	2,803
New Hampshire	14	----------	63
New Jersey	170	2	74
New Mexico	57	----------	9,772
New York	909	17	819
North Carolina	----------	1	1,230
Ohio	109	3	130
Oregon	9,510	2	1,694
Pennsylvania	148	8	184
Rhode Island	27	----------	77
South Carolina	9	----------	131
Tennessee	25	----------	352
Texas	136	----------	992
Utah	501	----------	807
Vermont	----------	----------	11
Virginia	6	----------	85
Washington	3,186	1	4,405
West Virginia	5	----------	29
Wisconsin	16	----------	3,161
Wyoming	914	----------	140
Totals	134,333	148	66,407

CHAPTER IX.

THE LAND AND ITS PRODUCTS.

Under the above head I have gathered together three articles which treat of their subject-matter so thoroughly and well, that I consider them eminently fit for reproduction in such a handy volume of reference as I hope this report will be. The articles in question will be found under the sub-titles of "Labor and Statistical Problems of the Farm," from the pen of Prof. W. J. Sanborn, of the Missouri Agricultural College, Columbus, Mo.; "California Brandy and Wine Reports," and the "Barley Condition of the Country," compiled from the columns of the San Francisco *Chronicle* and *Bulletin*. They are prefaced by a table showing the acreage and distribution of the public lands of California.

THE PUBLIC LANDS OF CALIFORNIA.

THE PUBLIC LANDS.

Area of California	98,500,000 acres
Area of unentered government land	43,000,000 acres
Area suitable for lumbering, mining, and other pursuits	16,000,000 acres
Area suitable for some agricultural purpose	21,000,000 acres
Area of lakes, bays, navigable rivers, and lands steep or rocky, or otherwise not productive	6,000,000 acres

WHERE THE LAND IS.

Counties.	Acres.	Counties.	Acres.
San Luis Obispo	450,000	Sierra	210,000
Monterey	600,000	Yuba	40,000
San Benito	250,000	Butte	155,000
Santa Clara	100,000	Siskiyou	2,655,000
Santa Cruz	40,000	Alpine	465,000
Napa	40,000	Calaveras	250,000
Sonoma	165,000	Stanislaus	65,000
Lake	450,000	Merced	65,000
Mendocino	1,500,000	Placer	190,000
Shasta	1,500,000	Nevada	135,000
Lassen	2,700,000	Amador	255,000
Colusa	235,000	El Dorado	365,000
Yolo	65,000	San Bernardino	5,000,000
Tuolumne	655,000	Los Angeles	300,000
Santa Barbara	150,000	San Diego	2,500,000
Ventura	150,000	In 17 other counties	18,180,000
Kern	2,000,000		
Tulare	2,000,000	Total	42,245,000
Tehama	850,000	Humboldt county is estimated at	1,500,000

LABOR AND STATISTICAL PROBLEMS OF THE FARM.

The products of agriculture are the supporters of life, and the parent of all the arts; hence agricultural statistics are the most important of all statistics. They inform the producer, as well as the speculator, of crop prospects, and leave the fruits or profits of labor in the producers' hands, where they are of most good to civilization. As nations in the world's commercial system are no longer isolated units, statistics should be gathered on an international scheme. Your organizations are concerned with the labor, and with the productive industries of the State. In the aptitude of your field, I propose to discuss the labor problems of the farm in their relation to the social and material developments of husbandry.

THE WAGE LABORER.

The industrial revolution of this century, which has created new social and material systems, has assisted less the farm laborer than it has the wage laborer of any other important industry. The farm itself, in its relation to labor, has suffered a positive loss. Labor-saving machinery, in its division of labor into piece work, and railroads, have necessitated centers. Mechanism has shortened the hours of labor, and in its centers has created a social life attractive to labor. But expansion of labor-saving machinery on the farm has forced the laborer to seek other employment. The more spirited farm laborer has sought the schools, libraries, and social opportunities of the town. The barshare plow, requiring 3 to 4 men per acre a day of plowing, has given place to the sulky plow, asking for one man per day for 3 acres of plowing. The corn planter has replaced 10 men; the mower, 4 to 5; the reaper, 10 men; and so on for other field operations. The Titan strides of agriculture are revealed in the annual productions of farm mechanism, amounting to $68,940,486 for 1880. Corn planters numbered 68,991; grain drills, 43,222; grain sowers, 20,289; cultivators and harrows, 446,054; plows, 1,326,123; harvesters, 25,737; reapers, 35,327; reapers and mowers combined, 54,920; mowers, 72,090; rakes, 95,625; potato diggers, 33,453; and corn huskers, 44,370.

All farm machinery and implements are covered by 35,960 patents, marking a movement unparalleled by any age, or by any other industry. Our exports marked the increased power of the laborer on the farm. Those of agriculture are 77 per cent of our entire exports, and amounted to $619,269,499 for 1883. Within a half century they have gone up from little over $4,000,000 annually. The remark of Socrates that "agriculture is the mother and nurse of all the industries," is no mere sentiment for American application.

When our population numbered 80 per cent of farmers we exported little. In 1860 it was 51 per cent only engaged in agriculture; in 1870, 47.35 per cent; and in 1880 but 44.1 per cent of all workers were farmers. But with the decrease of the ratio of farms and farm laborers in ratio to population has come an increase of products for exportation. Sir, agriculture has been no laggard, but challenges our admiration. It has measured the advance of social and industrial progress through the labor its better methods have given to the arts. Within a lifetime it has given one half its former ratio of workers to other callings. Headless and heartless, this farm mechanism has sent to the town the best farm labor to occupy positions of minor trust and to satisfy its gregarious instincts in society. This impulse has been aided by the uncertainty of the tenure of farm labor, and its certain long hours of labor. Seven months of sun to sun labor, followed by five months of intermittent and uncertain labor, with its saloon companionships in hours of idleness, has been demoralizing to farm labor. Such laborer, boarded in the family of the farmer, is a burden to the wife, and often a moral pest to the children. The old polity has been wrecked and a new will secure the best labor of the day; in my experience, by the cottage home for the laborer on the farm and for his family, with a garden, a cow, pig, newspaper, and steady employment by the year. These bind labor to the farm and to its interests. The system of farming that distributes labor over the year is the most profitable. Landed interests are deeply concerned in securing good labor against the seductive influence of the town, and does not want the nerveless labor the latter refuses. Good homes, regular labor, and stated hours, will secure it, as experience teaches. It also induces conservatism in the laborer. He is never a striker, and property finds no enemy in his person. Mechanism has rendered the barbarism of extreme long days of labor, peculiar to the farm, unnecessary. Indeed, ten hours is sufficient to exhaust the normal capacity to work, when faithfully applied.

The diversity of farm operations requires more tact and the executive faculty better developed in the farm laborer than in the labor of any other industry; hence education of the farm laborer is of more importance than the education of any other class of laborers. I have handled upon three large farms four distinctive classes of farm labor, and must unequivocally indorse the educated farm laborer. He has clearer views of the just relations of capital and labor, and is not only a less captious, but is a more perceptive workman. A comparison of northern with southern labor shows this. But Europe presents less abnormal causes and a far greater proportion unable to read and write than the United States. According to Mulhall, Europe produces 16.5 bushels of grain per capita, and the United States 48.1 bushels. Europe produces 51.1 pounds of meat per capita, and the United States 171 pounds. Europe produces 15.06 bushels of grain per acre, and the United States 23.3. We till more acres per laborer here by these figures. Portugal had but one in thirty-six at school, and grew 11.64 bushels of grain per acre. Spain has 25 per cent of her population able to read and write, and grows 12.2 bushels of grain per acre. France had in 1860 58.2 per cent of her population able to read and write, and obtained 18.5 bushels. In Germany the bulk of population read and write, and her farmers gain 22.05 bushels per acre. While it is true that production follows expansion of manufactures and commerce, it must be remembered that the diffusion of knowledge is the impulse that has developed arts and commerce, and that has created the culture and wealth to enjoy their fruits. Educated farm labor has enjoyed the fruits of its own energy, and the energy of other educated labor. The Department of Agriculture finds that the manufacturing Eastern States pay for farm labor $26 61 per month, while the Southern States pay $15 30. Ohio pays $24 55, and Kentucky, by its side, $18 20. The manufacturing sections of Ohio pay $25 96, and the non-manufacturing sections $22 65. Vermont, manufacturing the least of the New England States, pays $23 70 per month. She has invested in manufacturing $28 80 per capita; while

Massachusetts pays $30 66 per month for farm labor, and has invested in manufactures per capita $74 40. Steadily employed farm labor is as well paid as any labor. By Carey's figures in 1836, the price of farm labor had increased, by 1866, 72 per cent; and by Caird, English rates, from the repeal of the corn laws, had advanced 60 per cent. In the hands of the better class of farmers, his hours of labor have been much reduced. Meat twice a day, tea, sugar, tobacco, carpets, and a paper are now his to enjoy.

PROPRIETARY LABOR.

While a broad distinction exists between wage and proprietary labor, yet in this country the latter is a laborer even in the physical sense of the word. Here the proprietor is the tiller of the soil. The census shows 3,323,876 farm laborers and 4,346,617 farmers, most of whom own the land they till. Herein lies the success of our agriculture against European. Grand results come only from the quickened perception and energy that ownership gives. Ownership is the parent of all broad permanent farm improvement. The history of Rome and Greece teaches it. The spiritless farming of Spain, Italy, and Austria, and, in fact, most of Europe, rests in the entailed mischiefs of feudalism, whose influence lives on.

Two States, adjoining, were formerly typical of two systems of labor and land ownership. In 1860 Ohio farms averaged 114 acres; those of Virginia 324 acres. Ohio raised 15.1 bushels of wheat per acre, and Virginia 9; corn, Ohio, 31.3 bushels, and Virginia 19.1; oats, Ohio 26.4 bushels, and Virginia 16.2 bushels. The war converted the owners of the soil, to a large degree, into its tillers. The following figures are those of a revolution in practice: The farms of Virginia decreased in size from 1860 to 1880 from 324 to 167 acres; in South Carolina, from 438 to 143; in Louisiana, from 536 to 171; in Mississippi, from 370 to 156 acres. This colossal movement has given a new agricultural South, four of whose Atlantic States have increased their wheat yield from 7.3 bushels from 1862 to 1875, to 7.7 bushels, in the period from 1875 to 1882, or 5 per cent in seven years. Our people love the land in spite of the cry that young men set their faces cityward. This is displayed in the average size of the farms, which, in 1850, was 203 acres, in 1860, 199 acres, in 1870, 153 acres, and in 1880 only 134 acres.

Statesmen are interested in land ownership by the masses. It means stability of government. Especially in democracies are a landless people more dangerous than an ignorant one. Machinery has not tended to centralization on the farm as in the shop, as expected. Mammoth enterprises have been wrecked, insuperable obstacles presenting themselves after the first fertility has been exhausted. The great estates on the plains, now gathering, will inevitably fall apart from the same causes that are reducing the average size of our farms. Ownership by the tiller of the soil may be insisted upon as the first requisite to successful labor on the farm.

MEDIUM SIZED FARMS

Are a second favoring condition to the economy of labor on the farm. Statesmen, observing that equality of condition and land ownership among the masses, for all time, have tended to stability of government, have been pronounced advocates of "extensive farming." Love-lye says, "Modern democracies will only escape the destiny of ancient democracies by adopting laws such as shall secure the distribution of property among a large number of holders, and shall establish a very general equality of condition." Students of ancient and modern history will recall the efforts of legislators and thinkers to secure land ownership in small holdings for the masses. France has 5,550,000 properties, of which 500,000 only average over 60 acres, while 5,000,000 are under six acres. In England and Wales not one in twenty own property, and 7,000 own over four fifths of all England. Which of the two systems choose we? England raises twenty-eight bushels of wheat per acre, and France fifteen. The six-acre farmer of France is forced to live in the past. The spade and manual labor do the duty of the plow and the horse. It is the system of brute force. It creates indolence rather than thrift, for the small corn and wheat farmer cannot occupy himself one half of the time advantageously. This narrow circle breeds mental stagnation, and clothes the French peasant in wooden shoes. Britain consumes 47 per cent more meal than France. With 51 per cent of her population engaged in agriculture, France buys food, while America, with 134-acre farms, sells heavily, with 44.1 per cent of her toilers farmers. It is the earnings, and not the savings, that constitute the true wealth and happiness of a people. The capacity to earn measures the genius of a people. Americans have understood this matter, and assert the dominance of mind over matter, and use animal and natural forces. In 1870 we had 1,321,117 farms under fifty acres. In ten years this number decreased 145,703. Machinery must have free play, and it drives small farmers remorselessly from the field. We are looked upon as the great rural nation of the world, although of a less proportion of farmers, by far, than Europe. It is the genius of mechanism that has misled the world in this view. Neither small nor large farms, then, in view of preceding statistics, favor labor best; 150 acres is large enough for machinery, and not too unwieldy for intensive methods. What coöperation may yet do, the future must answer. At present, man works best by the ownership of medium sized farms.

CAPITAL WITH LABOR.

Thirdly, capital may be regarded as the right arm of labor, when applied to agriculture, as elsewhere. "Intensive farming" narrows efforts, and divorces machinery. "Extensive farming" is broad areas, tilled with little capital, and poorly. Capital and skill combine the two, and give "intensive" "extensive" farming—large crops on broad areas, forty bushels of wheat in the place of our twelve bushels.

The United States, in stock and tools, uses but about $6 60 per acre of improved land, and a small additional sum for accessory personal property. A pioneer type of farming is revealed, based upon soil robbery, and does not touch the capacity of the man or the farm. The gross income per acre is but $6 77—a sum which, by capital, machinery, skill, rotations, etc., can be easily multiplied sixfold. It is to be regretted that the plow has been sped faster than the furnace, the anvil, and the loom, robbing the bounty of ages to fatten foreign lands, selling grain at a price that the sons will pay to replace exhausted fertility. Professor Collier has shown that the depletion in the second of two periods of nine years lost to the West, in yield per acre, $30,000,000 for corn, while the East gained $45,000,000. California has dropped, from 1862, from 24½ bushels of wheat to 13 bushels per acre. Missouri, in periods of five years each, has dropped from 14 to 12.4, to 11.9, and for the last five years to 11.7 bushels per acre. In corn a bushel less every five years is grown. The East is capitalizing its farming, and paying for the follies of its fathers in soil replenishment.

A table from Professor Schwertner shows the two movements. By it nineteen years are divided into four periods of five years each, save the last, of four years.

Period.	Kansas	Missouri	Iowa	Nebraska	Minnesota	Maine	New Hampshire	Vermont	Massachusetts	Connecticut
1	17.2	15.1	13.7	16.0	17.0	12.9	14.2	15.1	16.5	16.5
2	16.9	14.0	13.7	17.7	14.7	12.7	14.5	14.5	17.1	17.1
3	14.4	13.2	11.9	12.4	15.2	13.8	15.9	15.9	17.2	17.2
4	13.1	13.1	11.1	12.7	14.3	13.7	14.5	14.5	16.5	16.5

In the group of food-selling States, having but 58.5 per cent of their population engaged in agriculture, the crops are on the decline. In the food-buying States, 28.1 per cent are farmers, and the soil is gaining in crop yield. The former scratch the soil and sell the crops, raw products. Theirs is the simplicity of farming. Look at the decline of Kansas in fifteen years. From her 1,534,350 acres of wheat, 6,280,855 bushels of wheat, worth $4,396,584 50, are lost annually in decline per acre, or $287 for every 100 acres. Exhaustion has spared no section of America, and leaves but day wages for labor at its low ebb for most sections. Kansas loses more than named. Selling 15,000,000 bushels of wheat carries away 18,920,000 pounds of nitrogen, 71,000,000 pounds of phosphoric acid, and 4,620,000 pounds of potash, soil ingredients of crops, most of which might have been retained by a rational system of farming, and which the East is now buying at the rate of $4,820,800 annually. The loss to the United States is enormous, and is our shame, rather than our pride, as statisticians and statesmen feel it to be. Are the sale of raw products a country's glory?

I have arranged from Mulhall data showing the relation of commerce and the manufacturing of raw products to good farming:

	Earnings of Commerce and Manufactures in Shillings per Head.	Yield of Bushels of Grain per Acre.
Great Britain	838	36.40
Holland	780	28.80
United States	475	23.30
Belgium	684	32.72
France	439	18.50
Austria	137	15.04
Spain	153	20.20
Italy	151	13.80
Portugal	110	11.64
Germany	359	20.05
Russia	109	10.25
Europe	290	15.06

The exceptions to the rule that the products of agriculture follow the earnings of commerce and manufactures are easily explained.

INDUSTRIAL EDUCATION

Is a fourth aid to agriculture. As this section was a condensation of a broad subject in its original scope, the writer will merely say in this synopsis that all the reasons urged in favor of professional education for the lawyer, civil engineer, etc., and more, may be presented in favor of industrial education for the farmer. His products are "the materials of art;" he sets the price of food. His industry involves the laws of the natural sciences. No art is so complex, and until this century none so poor in known facts. To-day the 150 private and public experiment stations, with nearly 1,000 trained original investigators, are amassing the richest industrial literature of this or any other age. These facts are so extensive and scattered as to require systematic organization and schools to impart them to the young. The industrial value of those facts only the sheerest ignorance or narrow prejudice can question. Grasping the principles of his business, broadens farm labor in the farmer, divorces him from the costly and painful acquisitions of experience, and emboldens policy. It makes the aggressive farmer, as well as the skillful one. It lays the foundations of his system of farming broad and deep, and builds it for the ages. All civilization rests upon the plow; let reason be its guide.

BEARINGS OF STATISTICS UPON OUR FUTURE DEVELOPMENT.

In 1860 we raised 46.0 bushels of cereals per capita; in 1870, 50.8 bushels; in 1880, 53.7 bushels per capita. Ten years ago we exported $497,760,867 worth of farm products; last year $619,269,632 worth. Fifty years ago our exports in round numbers were $4,000,000 worth annually. Mathematicians have figured this ratio of gain into the future to the wealth and glory of our country. I neither desire nor expect this gain. Rapid commercial changes are bringing our competitors to the front in grain and meat products. Our own good and cheap lands are overrun. Beyond the one hundredth meridian the rainfall varies from three to twenty inches to the base of the mountains. This meridian cuts off one third of Kansas, nearly one half of Texas, Nebraska, and Dakota. Seventeen counties of western Kansas actually fell off in population last year. Texas, settled largely by enterprising men within fifteen years, grows 8.5 bushels of wheat and 17.5 bushels of corn per acre. Its great area is best fitted for grazing, requiring twenty acres to a steer. The number of farms increased from 1870 to 1880 50.7 per cent, while the increase of improved acres was but 31.5 per cent, showing that the settling up of land overspread is going rapidly forward.

In 1860 we grew of all animals 2.9 per capita; in 1870, 2.2; in 1880, 2.7, and in 1884 2.5 per capita. The "babies" are increasing faster than domestic animals. The increased size of animals, however, keeps our meat supply good. Our dairy products per capita are about what they were in 1850. We have $200,000,000 worth of sugar yet to produce, $100,000,000 worth of which we now buy. We have more wool to grow, all our fibers nearly, tropical fruits and other farm products, and shall have, by the year 1900, 35,000,000 more of people to feed. This 35,000,000 will more than ever settle in centers of industry, or become consumers. What good lands have we? From 1870 to 1880 the acres of land in farms increased 12,834,679 yearly; 1,016,697 of those acres only were taken in States or Territories west of those crossed by the one hundredth meridian, and, liberally estimated, 1,000,000 in those States thus crossed west of this line; 11,000,000 acres, or 84 per cent of land occupied, was, then, taken east of this meridian. New Mexico actually decreased the area of her farms. One third of the country lies west of the one hundredth meridian. The land east of the one hundredth meridian is 968,391,039 acres. In farms, 494,475,095 acres. Improved acres, 256,334,955. West of the above line only 28,436,039 acres are found. What of the half area east of the one hundredth meridian not in farms? The original thirteen States, all but four of which are Northern and manufacturing States, have 210,539,520 acres in total. Of this, 136,955,946 acres are unimproved, and 71,489,236 acres are not in farms. One third of the area of those States is not inclosed, and only 34.9 per cent is improved. Lands thus passed by will come slowly into use—much, never.

At the same rate of settlement only 337,968,472 acres would be improved under the present order of events, and seven years from 1880 would suffice to absorb those unoccupied. But they are not representative States, and we strike her unimproved 136,955,946 acres out as of little moment. Michigan, Wisconsin, and Minnesota form the next group, with 124,099,840 acres of land, with only 24,506,084 acres improved. 100,000,000 acres, or 80 per cent, in these semi-old, northern, cold, forest States is unimproved. Indeed, some counties have gone back in rural population; their sons seeking in other States for better lands. Ohio, Illinois, and Indiana are the best settled States, and have 76,623,854 acres of improved lands out of a total of 82,677,120 acres, including wastes, rivers, etc. It is idle to look here for land. Iowa even in 1880 had 24,752,700 acres in farms out of 38,228,000 acres. We have stated the depopulation of western Kansas. In brief, it is in seven southern States that the great reserve of land is found. Texas, east of the one hundredth meridian, Louisiana, Mississippi, Alabama, Arkansas, Florida, and Georgia contain 250,471,021 acres, of which but 94,416,465 acres are in farms, and only 35,080,580 acres are improved. They will make cotton, and perhaps our sugar, and fibers, and tropical fruits, but they do not feed themselves, and will not soon swell our commerce. The wheat crop of last year varied in these States from 5.1 to 8.5 bushels per acre. Will dollars, labor, and 6 bushels of wheat per acre on impoverished lands, none too good, and in an unfavorable climate for energy and grain, secure the markets of Europe against cheaper labor and favoring climes? One half of this southern area is Texas and Florida lands, poor, very much of it. Theoretically, I am among the first to recognize the fact that our resources are almost untouched, but, practically, lands rejected will be occupied only under a new order of events.

At the present rate of increase, in less than one hundred years our population will number 400,000,000. It will not likely reach 200,000,000, 100 years hence. But in any event the year 1900 will open with less exportation of produce, and will soon see our own expanding centers pressing our farmers into better methods to supply their wants, while our centers will better supply our own country with all the works of art or industrial products. I confidently expect to see

American agriculture take on more of the methods of a settled country, becoming more intensive and less extensive in its characteristics. The nomad farmer has nearly had his day, and has about completed his work. Henceforth we are to see more of the genius of farming in this favored country. The gleam of the American "coulter" in the fat soil it cuts, shall reflect in the future typical lord of the soil qualities of the mind, like the coulter and the soil, polished and fertile.

CALIFORNIA BRANDY AND WINE REPORTS.

The juice of the grape has been an article of export for at least a quarter of a century.

Unfortunately there have been no well kept statistics of this trade for that period. In early years, simply the number of packages exported was recorded. Later on, the value of the contents of these packages was entered. Still later, the bulk wines were kept separate from the case wines, and the former were reported in gallons, with the value of both combined. At a latter period, case wine values were kept distinct from bulk wine values. In 1870, the railroad people commenced to carry wine, and that introduced another disturbing element to prevent accuracy in the statistics, since these wines by rail were simply reported by weight, leaving the statisticians entirely in the dark as to the proportion of case to bulk wines in the exports by land carriage, while no values were given.

It will thus be seen that anything like an accurate idea of the quantity and value of brandy, and bulk and case wines of California manufacture exported in the last twenty years, is extremely difficult to give.

The export of California brandy have never been very large. Up to 1871, the quantity was reported in packages, and since then in gallons. The price has varied according to the age and purity of the article. In 1868, crude California brandy sold at $1 25, while choice old commanded $2 50.

The value of the exports by sea since 1871, have ranged from $1 75 to $2 25 per gallon. For the purpose of making the figures uniform, we will assume that the brandy exported prior to 1871, averaged $2 per gallon. The exports by sea for the past twenty years would therefore be as follows:

Years.	Gallons.	Value.	Years.	Gallons.	Value.
1864	15,000	$30,000	1874	44,100	$86,900
1865	25,000	50,000	1875	40,200	85,300
1866	1,000	2,000	1876	36,900	74,400
1867	2,100	4,200	1877	64,900	122,500
1868	20,500	41,000	1878	91,300	167,600
1869	103,000	205,700	1879	98,900	193,200
1870	63,000	124,400	1880	97,600	196,600
1871	52,300	105,800	1881	61,900	132,900
1872	58,200	122,700	1882	44,600	99,000
1873	60,800	129,300	1883	36,000	69,000

As before remarked, it was not until 1866 that any values of California wine exports were kept, and it was not until 1869 that the bottled wine was kept separate from the bulk wine.

In order to make our table of exports uniform we shall have to estimate the number of gallons prior to 1869 by the values entered. The record of the California wine trade by sea since 1864, a period of twenty years, has been as follows:

YEARS.	Gallons.	Cases.	Value.	YEARS.	Gallons.	Cases.	Value.
1864	190,000	1,000	$100,000	1874	577,900	5,300	$404,200
1865	200,000	1,500	110,000	1875	498,400	3,700	324,100
1866	311,600	2,000	167,800	1876	508,500	3,100	332,000
1867	245,000	2,500	137,600	1877	887,300	3,600	518,100
1868	359,000	3,500	179,600	1878	1,227,900	6,600	675,400
1869	451,700	8,500	401,900	1879	1,388,800	4,200	756,300
1870	432,200	6,900	364,300	1880	1,420,700	4,600	774,300
1871	479,100	8,300	383,108	1881	1,494,300	4,400	826,600
1872	532,200	9,100	415,000	1882	1,454,600	4,200	832,100
1873	444,400	7,200	337,700	1883	1,262,000	3,300	682,400

We find no shipments of California brandy in the railroad exports until 1874, though California wine shipments by that route were reported as early as 1870, or within eight months after the road was first opened through to New York.

The returns by the overland routes are given in pounds. While most of the wine and brandy by rail has gone directly from San Francisco, there have been free shipments from San José, Stockton, Sacramento, and Marysville. For the past three years, or since the opening of the southern route, Los Angeles has been added to these interior shipping points. Up to 1882 Sacramento was the largest interior shipping point to the East of California brandy and wine, but for the past two years Los Angeles has taken that position, and is likely to hold it since there are large wine interests in Los Angeles and other southern counties; and now that there is an outlet direct by rail to the Eastern States through Arizona, most of the product manufactured south of Santa Clara County will naturally take the southern route. The manufacturers in that section appreciate the facilities for reaching distant markets given by the railroad.

The railroad returns of California brandy and wine exports since 1870, from all parts of the State to the East, are as follows:

YEARS.	Brandy—Pounds.	Wine—Pounds.
1870	----------	1,578,900
1871	----------	2,145,100
1872	----------	464,800
1873	----------	526,800
1874	38,900	558,500
1875	368,400	5,136,500
1876	251,900	5,568,500
1877	687,000	5,426,400
1878	399,600	5,717,500
1879	746,400	7,924,800
1880	915,700	9,420,600
1881	1,252,700	12,904,100
1882	1,837,200	14,464,800
1883	1,880,200	18,972,000
Totals	8,378,000	90,809,600

These are gross weights, and, of course, include the weight of the packages. It is estimated that the net gallons represent one tenth of the gross weights.

According to this we have shipped 837,800 gallons brandy by rail in the past ten years, valued at about $1,675,600; and 9,080,960 gallons wine in the past fourteen years, valued at $4,540,480.

Of this wine by rail, 8,609,400 gallons was shipped in the last ten years, valued at $4,304,700.

A large proportion of the wine shipments by rail has probably consisted of sparkling descriptions, which are worth more than still wines.

The exports of domestic brandy from California during the past twenty years may be divided as follows:

Years.	Gallons.	Value.
By Sea.		
1864–73	400,900	$815,100
1874–83	616,400	1,228,300
Totals	1,017,300	$2,043,450
By Rail.		
1874–83	830,800	1,675,500
Totals	1,855,100	$3,719,000

There has been some bottled brandy in the above exports, but the quantity has never been very large, and of course is entirely indistinguishable in the railroad export. This is also the case with the bottled wine exports by rail. The total exports of California wine for the past twenty years, so far as we have been able to get at the quantities and value, may be given as follows:

Years.	Gallons.	Cases.	Value.
By Sea.			
1864–73	3,615,200	50,500	$2,597,800
1874–83	10,720,400	43,000	6,125,500
Totals	14,335,600	93,500	$8,723,300
By Rail.			
1870–73	471,600		235,800
1874–83	8,609,400		4,304,700
Totals	23,416,600		$13,263,800
Brandy	1,855,100		3,719,000
Totals	25,271,700	93,500	$16,982,800

The above is considered a good record for this industry. Of course the bulk of the wine product is consumed in this State.

The yield during the past twenty years has been from 2,000,000 to 10,000,000 gallons per annum. At least, the latter figure was reported for 1882. The wine product of the State for the past seven years is estimated to have been 47,000,000 gallons, including 7,500,000 gallons in 1883.

THE BARLEY STATE OF THE COUNTRY.

California has the reputation of producing more and better barley than any other of the United States. The crop of the whole country varies from 40,000,000 to 50,000,000 bushels, of which California raises from 10,000,000 to 15,000,000 bushels. The census figures for 1880 give the acreage in barley in the United States at 1,997,700, and the yield 44,113,500 bushels. The States producing over 1,000,000 bushels barley in that year were as follows:

States.	Acres.	Bushels.
California	586,300	12,579,600
New York	356,600	7,792,100
Wisconsin	204,300	5,043,100
Iowa	198,900	4,022,600
Minnesota	116,000	2,973,000
Ohio	57,500	1,707,100
Nebraska	115,200	1,744,100
Illinois	55,300	1,229,500
Michigan	54,500	1,204,300
Total nine States	1,744,900	38,296,000
All other States	252,800	5,817,500
Totals	1,997,700	44,113,500

The barley crop of the United States for 1879 was estimated at 40,184,200 bushels, worth to the producers $23,625,300, against 42,245,-600 bushels in 1878, worth to the producers $24,483,300. The crop for 1881, 1882, and 1883 was probably the equal of the preceding three years, which shows an average of about 42,000,000 bushels per annum.

The exports of California barley from San Francisco by sea for the past twenty years have been as follows:

Years.	Centals.	Value.
1864	29,900	$40,000
1865	149,200	160,000
1866	284,900	328,000
1867	68,200	67,900
1868	80,000	174,700
1869	314,500	346,300
1870	159,400	184,300
1871	12,400	23,100
1872	176,100	222,900
1873	247,600	351,600
1874	222,600	361,600
1875	126,200	216,000
1876	351,900	414,500
1877	90,300	183,000
1878	304,000	410,300
1879	587,100	764,000
1880	490,600	631,200
1881	101,400	138,100
1882	183,900	279,300
1883	182,800	242,200
Totals	4,163,000	$5,538,500

This trade has been much larger during the last ten than during the first ten years, as will be seen by the following divisions of the totals:

Years.	Centals.	Value.
1864–73	1,522,200	$1,898,800
1874–83	2,640,800	3,639,700
Totals	4,163,000	$5,538,500

In addition to the shipments by sea as above set forth, the cars have been conveying barley out of the State for the past ten years. The first shipments overland were made in 1873, both from San Francisco and Sacramento. In 1874 San José entered the market as a shipper of barley overland. Marysville came in the same year, but has sent forward nothing since 1875. In 1878 Stockton commenced shipping. During the past three years Los Angeles has forwarded small lots, as Oakland has for the past two years. The shipments of barley from California, overland, since the commencement of this trade, have been as follows, the value being based on the shipments by sea for the same years:

Years.	Centals.	Value.
1873	25,245	$35,000
1874	455,092	718,000
1875	83,509	150,000
1876	148,761	178,000
1877	1,660	3,200
1878	159,467	217,000
1879	275,617	345,000
1880	584,713	730,000
1881	367,812	400,000
1882	44,346	66,000
1883	46,351	60,000
Totals	2,192,573	$2,902,200

This overland trade has been quite as important as the sea trade. The total shipments of barley from California during the past twenty years may therefore be summed up as follows:

	Centals.	Value.
By sea	4,163,000	$5,538,500
By rail	2,192,600	2,902,200
Totals	6,355,600	$8,440,709

About one half of the barley sent out of the State goes from the interior. The proportions from the city and interior points since 1873 have been as follows:

	Centals.
From San Francisco	1,174,523
From Sacramento	44,731
From San José	829,695
From Stockton	117,744
From Marysville	10,318
From Los Angeles	11,107
From Oakland	6,455
Total	2,192,573

The barley shipped overland is sent chiefly to the cities in the Western States, such as St. Louis, Chicago, and Milwaukee.

Some of the barley probably comes back to us in the form of beer from the great breweries of the West. The shipments by sea have been mainly made to Australia, Europe, New York, and Philadelphia. Occasionally full shiploads have been sent to these different markets.

There is more barley consumed in the United States every year than is raised. The imports and exports for the past ten fiscal years bring out this fact very prominently, and are herewith annexed as reported by the Bureau of Statistics at Washington:

Years.	Imports—Bushels.	Exports—Bushels.
1873–74	4,891,200	320,500
1874–75	6,255,100	91,000
1875–76	10,286,000	317,800
1876–77	6,703,000	1,186,100
1877–78	6,764,200	3,921,500
1878–79	5,721,000	715,500
1879–80	7,135,300	1,128,900
1880–81	9,528,600	832,200
1881–82	12,182,700	205,900
1882–83	10,050,700	433,000
Totals	79,317,800	9,155,400

Thus within the past two years we have used 70,000,000 bushels barley in excess of what we have produced. The barley is mainly imported from Canada. The cost of the 79,317,800 bushels barley imported into the United States in the past ten years is $64,429,700, or a little over 80 cents per bushel of 48 pounds. Our farmers would like to realize that figure for their barley year after year.

The crop of barley in California was probably the largest in 1880. The deliveries at San Francisco for the harvest year of 1880–1881 were the largest in the history of the trade, amounting to 1,794,200 centals. Probably not over one fifth of the barley raised in California finds its way to San Francisco in any year. On the first of January, 1884, the stock of barley in California, according to the returns of the Produce Exchange, was 2,434,100 centals, against 1,941,500 centals on the first of January, 1883.

The shipments since January first have been moderate and mostly by cars, the returns of which have not been made public, except

13,000 centals for the month of January. It is not getting too late to ship overland, as the malting season closes with the approach of hot weather. It is thought the new crop of barley will be equal to the stand of 1880, as there are over 600,000 acres under cultivation in the State, and the estimated yield is at least 10 centals to the acre. There is still considerable barley in the State from previous crops. The need is a greater home consumption for this cereal.

CHAPTER X.

TRADE INTERESTS.

Three articles are segregated under the above heading, the first on "What we Buy and Sell—From and To Whom," being a compilation from a quarterly report of the Bureau of Statistics, at Washington, D. C.; and the other two treating of those important industries, "Bags and Burlap," and the "Lumber Export Trade of California," more attention being given to them here than was convenient in Chapter II on "Industrial Developments."

WHAT WE BUY AND SELL—FROM AND TO WHOM.

The trade statistics of a country furnish an interesting study. In the United States the Bureau of Statistics at Washington collects from all the ports every month the quantity and value of all that is imported from foreign countries and exported to foreign countries. The report for the last fiscal year has just been received. Three pages of the document are devoted to the commerce of California, Oregon, and Washington Territory, with reference to its relation to the transportation question.

For the last fiscal year the value of imports into these three States (though Washington Territory is not yet a State) was $46,865,872, while the value of the exports was $53,468,647, or a total of $100,333,-519. This of course refers only to the foreign trade. The inter-State trade is also a considerable item, but the figures are not accessible. Of the value exported to foreign countries, $36,904,900 was for breadstuffs, being 70 per cent of the grand total. Five years ago the breadstuffs shipped from this section of the country was only $17,142,-900. Should we gain in the same ratio for the next five years, the total would be about $80,000,000 for June 30, 1888. Most of the flour has hitherto been shipped by water. It is possible that some of it will hereafter be shipped by rail.

THE COUNTRIES WE DEAL WITH.

It would be easier to name the countries with which we have no commercial intercourse than those with which we trade to a greater or less extent. Taking imports and exports together, our largest business, of course, is with the United Kingdom of England, Ireland, and Scotland. The combined value of what we buy from the United Kingdom, and sell to it, is within a fraction of 40 per cent of what we buy from and sell to all other quarters of the world.

This accounts for the close and amicable relations between England and America. We are not so much dependent on Great Britain as Great Britain is on us, for while we bought from that country last year merchandise to the value of $188,622,800, we sold to that country a value of $425,424,200. France comes next in importance, our commerce with her being 10½ per cent of the whole. But here the conditions are reversed.

France sold us a value of $97,989,200, and bought from us a value of only $58,682,200. Germany is our next best customer, and with her our relations are more evenly balanced. Our commerce with Germany was about 8 per cent of the total. We bought $57,377,700 from her, and sold her $66,169,900. Thus from these three European countries we have about 58 per cent of our foreign commerce. The other 42 is distributed among a large number of countries, and dependencies, the West Indies claiming nearly 8 per cent; the British North American Provinces nearly 6 per cent, and Newfoundland and Labrador nearly 5 per cent.

WHAT WE BUY.

Mr. Nimmo, chief of the Bureau of Statistics, makes fifty-seven classifications of imports for the fiscal year ending June 30, 1883. The total value of the free and dutiable goods imported into the United States during that year was $723,180,914. In the order of importance, sugar and molasses form 13.73 per cent of the total. We paid $91,539,300 for sugar and $7,787,065 for molasses, etc. If sweetness alone could make people pleasant, we ought to be very amiable, for our sugar costs us more than any other one article of food. The next heaviest item is wool and woolen goods. This bill was $55,224,-284, or 7.64 per cent of the total.

This is all the more remarkable in view of the large wool product of the country, and the further fact that sheep husbandry is capable of a greater expansion than yet reached.

The bill for raw wool alone was $10,949,331. Perhaps some of this was necessary for mixing. The bill for woolen cloth was $44,274,952. How much of this cloth was made from American wool, and whether any of it was superior to American goods, we have not the means of knowing. After wool comes silk and silk manufactures, the total for which was $50,807,616, or 7.03 per cent of the total. This total may be divided into $14,043,340 for raw silks used in the factories of California, New Jersey, and elsewhere, and $36,764,276 for silk manufactures used by nearly everybody, whether rich or poor. As many people can afford to use silk, and as very little raw silk is produced in this country, it is gratifying to know that we have gone into the manufacturing of silk on the scale indicated above. The list of articles embraced under the next classification is a somewhat lengthy one. It covers many of the goods found in drug stores, most of which are recommended to either cure or kill those who use them, if only persistent in their use. Mr. Nimmo names them as chemicals, drugs, dyes, and medicines, but the subdivisions to which each of these articles is capable are too numerous to mention and read in the same day. The bill for these articles was $43,126,286, or 5.96 per cent of the total. The judgment of the Court is that in most cases the money was well spent, and all the doctors, coroners, and undertakers of the country concur. The coffee we drank last year cost us $42,050,513, or 5.81 per cent of the total. What the other materials thrown in with the coffee cost is not given. Iron and steel and manufactures of the same cost us $40,796,007, or 5.64 per cent of the total, and yet we claim to produce considerable iron and steel in this country. As recently stated, there was 5,146,972 tons pig iron produced in this country in 1883, and 1,654,627 tons Bessemer steel. We also refer with pride to the shipments of American cutlery and other hardware to Europe. There is evidently a good deal of reciprocal trade in the iron and steel business. Cotton is often referred to as king in the export trade of the country, and so it is, but somehow we have to go abroad for a good many kinds of cotton goods, the total last year under that head being $37,654,221, or 5.21 per cent of the total. The value of hides and skins, exclusive of furs, was $27,640,030, or 3.82 per cent of the total. With a country capable of sustaining so many animals as America, we ought to retrench a little in that direction in the future. Tin and the manufactures of tin costs us $23,917,837, or 3.31 per cent of the total, and yet there are some good tin mines in this country. Flax and the manufactures of flax cost us $19,727,543, or 2.73 per cent of the total. Farmers will soon see the utility of devoting more attention to the cultivation of this fiber. Fruits of all kinds, including nuts, cost $19,313,041, or 2.67 per cent of the total; yet there are few fruits or nuts that cannot be produced in some part of the United States.

There are nine other articles, or classification of articles, which cost from $1,000,000 to upwards of $17,000,000, the principal one being tea, which is put down at $17,302,849. This is considerably less than our bill for coffee. It may be some consolation to the enemies of the twin evils to know that our foreign wines, spirits, and cordials, cost us only $12,308,307 in the last fiscal year, and our foreign tobacco and tobacco manufactures, $11,771,596. But the money spent for domestic liquors and tobacco was many fold more.

WHAT WE SELL.

Mr. Nimmo gives fifty-three classifications of domestic merchandise exported in the fiscal year ending June 30, 1883, the value of the whole being $804,223,632. The claim that cotton has always had is well maintained in this summary, as the total for cotton and the manufactures of cotton is $260,279,850, or 32.36 per cent of the total. As an offset to the $36,000,000 of manufactured cotton imported, it is some satisfaction to know that the cotton manufactured exported, amounted to $12,951,145, leaving a value of $247,328,721 for raw cotton, nearly every pound of which is produced in a few of the southern and southwestern States. The next most prominent line of exports covers bread and breadstuffs, the value of which was $208,040,850, or 25.87 per cent of the total.

Provisions are given at $107,388,287, or 13.35 per cent. The value of mineral oils (by which is meant petroleum), is stated at $44,913,079, or 5.58 per cent. Wood, and the manufactures of wood, are set down at $26,793,708; iron and steel, and the manufacture of the same, $22,826,250; tobacco and its manufactures, $22,095,229; and live animals, $10,789,268. These are the only classifications that reach a value of $10,000,000. There are fourteen other classifications that range from $7,923,662, down to $2,348,004, and eleven more from $1,000,000 to $2,000,000 each.

The value of domestic exports for 1882–83 may be more generally classified as follows:

	Per Cent.	Total.
Agricultural products	77.00	$619,269,449
Products, domestic, manufactured	13.91	111,890,001
Domestic products, mining	6.40	51,444,857
Domestic products, forest	1.24	9,976,143
Domestic products, fisheries	0.78	6,276,375
Other domestic exports	0.67	5,366,807
Totals	100.00	$804,223,632

In the line of raw agricultural products, as before remarked, cotton takes the lead, showing a value of $247,328,721. The next item is wheat, $119,879,341; then wheat flour, $54,826,459; bacon and hams, $38,155,952; Indian corn, $27,756,082; lard, $26,618,048; leaf tobacco, $19,438,066; and cheese, $11,134,526. These are the only items that show a value of $10,000,000 and upwards.

Horned cattle were exported to the value of $8,341,431, and fresh beef to the value of $8,342,131.

In the line of products of domestic manufacture, the leading item is $20,996,304 for wood manufactures; $19,024,894 for iron and steel manufactures, and $12,901,145 for cotton manufactures. There are sixteen more articles of domestic manufactures which vary from $7,923,662 to $1,018,138; in the line of domestic products of mining is $40,555,492 for refined mineral oils, and $3,914,941 for crude oils, besides $4,241,247 for coal. The contribution from the forest embraced a value of $3,068,132 for rosin and turpentine, $3,102,232 for timber, sawed and hewed, and $2,401,021 for whole timber. The importance of agriculture in the commerce of the country is well understood; old mother earth is well named, for all life is sustained by her; the exports of raw products of the earth form 70 to 80 per cent of the entire domestic exports of produce and merchandise.

Since 1870, the annual proportion has varied from 72.63 in 1877, to 83.25 in 1880, a difference of over 10 points. As far back as 1820, the same conditions are observed. The value of agricultural products shipped in the last fiscal year was the largest, with two exceptions, in the history of the country. These exceptions were 1879–80, and 1880–81, when the totals were $685,691,091 and $730,394,943, respectively. The shipments of bread and breadstuffs never footed up a value of $100,000,000 until 1873–74, and since then the total has never been under $111,458,300, and in 1880–81, it was $270,332,500. The largest total for raw cotton was in 1865–66, when the value of the exports was $281,385,200. In 1878–79, the amount fell to $162,304,200. Since then, there has been an increase of $85,000,000 in this item. It was not until 1876–77 that provisions showed a value of $90,000,000 per annum. Since then, the items under that head have varied from $107,388,300 to $151,528,300, the larger total being for 1880–81. Mineral oil was added to the exports about twenty years ago. From a value of $10,782,700 in 1863–64, this item rose to $61,789,400 in 1876–77. It has since been as low as $36,218,600, but was more than $8,000,000 higher than that last year.

Tobacco exports nearly doubled between 1830 and 1840, and the same thing occurred between 1840 and 1880. The largest total in this line was $45,307,900 in 1864–65.

COMBINED COMMERCE.

Prior to 1850, the total foreign commerce of the country varied from $200,000,000 to $300,000,000 per annum.

This includes the value of all the merchandise and specie imported and exported from the country. Only three times previous to 1850 did these totals exceed $300,000,000, and then not to the extent of $20,000,000 in either of the three years. From $330,637,000 in 1849–50, the annual total rose to $762,288,500 in 1859–60, a gain of 130 per cent. For the next ten years, the foreign commerce of the United States was quite irregular, and there was good cause for the irregularity, as during the interval the country passed through one of the most extensive and costly civil wars of modern times. The totals for 1859–60 were not reached again until after the war, while in 1861–62, one of the war years, the total commerce of the country fell to $433,329,900. In 1869–70, the amount was $913,305,000, or more than double that of 1861–62, but only 20 per cent more than that of 1859–60. Since 1870, the statisticians have been obliged to add another figure in computing the amount. Since turning that total, the value has risen from $1,082,-755,900 to $91,675,024,800. This was the total for 1880–81, the bonanza year of the country; in the past — years the exports have exceeded the imports 25 times, while the imports have exceeded the exports 24 times, so that the honors are easy on that score.

But while the excess of imports over exports for the whole 49 years is about $790,000,000, the excess of exports over imports for the same period is about $1,500,000.

HIDES AND LEATHER EXPORTS.

San Francisco is the chief distributing point for hides and leather on the Pacific Coast. We receive from 200,000 to 250,000 hides annually from the interior of the State, Nevada, Oregon, and Washington Territory.

From 20,000 to 100,000 are also landed here from foreign sources, such as the Hawaiian Islands, Mexico, British Columbia, and Australia. Montevideo and Japan have also occasionally sent us small consignments. The price of dry hides in this market has varied from 12 cents to 20 cents in the past quarter of a century. The tanning trade was inaugurated about the year 1860. There may have been some tanneries in the State before that time. Now there are probably from 50 to 75 of these tanneries all over the State, and they pick up a good many hides from local sources. We have had a fair export demand for California leather during the past twenty years.

The figures under this head are not continuous, as the railroad has diverted shipments since 1869, and there are no accurate values to such shipments.

Twenty years ago the leather export trade amounted to $35,000 to $40,000 per annum. In 1868, it was $225,000.

Some years it has been even larger than that. These leather exports are made to New York, Europe, Japan, and other markets.

The shipments of hides from California were commenced very early in its history. At that time there was nothing else to do with them.

Of course the only market was New York. The shipments of hides from California by water since 1858 have been as follows:

Years.	Number.	Years.	Number.
1858	142,400	1871	68,900
1859	151,400	1872	86,700
1860	170,400	1873	76,100
1861	178,000	1874	107,200
1862	315,800	1875	128,000
1863	308,200	1876	94,300
1864	329,400	1877	49,700
1865	340,400	1878	6,300
1866	157,400	1879	10,100
1867	88,200	1880	1,900
1868	73,500	1881	100
1869	109,600	1882	7,800
1870	65,400	1883	300

In early years many salted hides were sent to the eastern market both by way of Cape Horn and also by the Panama steamers.

The shipment of wet hides across the isthmus and through the topics was attended with a good deal of risk, and for the most part only dry hides were forwarded. These shipments have been quite irregular. The number sent off in 1858 was actually larger than ten years later, though the heaviest shipments by water were made from 1862 to 1865. Since 1869 there have been a good many hides sent to New York by rail. Our first record of these shipments by rail dates from 1870. The returns of railroad exports are all given in pounds, and hence we give the record of these consignments separately, as follows:

Years.	Pounds.	Years.	Pounds.
1870	151,100	1877	4,712,400
1871	772,400	1878	4,209,300
1872	494,500	1879	5,262,200
1873	69,900	1880	4,455,700
1874	1,136,800	1881	3,354,900
1875	1,890,400	1882	3,355,600
1876	4,632,200	1883	2,717,800

The figures for the first four years in the table represent only the exports by rail from San Francisco.

In 1874, the first shipment was made from the interior direct to the East, consisting of 231,500 pounds from Marysville. In 1876, San José commenced shipping direct to the East by rail, and, in the following year, Sacramento. In 1881, the first direct shipment of hides to the East from Los Angeles was made.

In 1882, Oakland was on the list for the first time. The bulk of the quantity by rail, however, has always gone from San Francisco. In 1874, consignments of pelts were included in the same classification by the railroad people.

The proportion of pelts, however, has been small, amounting in

1882 and 1883, when kept separately, to only 261,000 and 463,000, respectively. These weights are not in the totals for those years.

The hide shipments from California by water in the past 26 years, may be given in periods of 6 and 10 years, as follows:

Years.	Number.
1858–63	1,266,200
1864–73	1,395,900
1874–83	405,700
Total	3,067,800

The small number for the last ten years is due to the operations of the railroad.

The exports overland, from 1870 to 1883, amounted to 37,215,200 pounds, or for the last ten years 35,727,300 pounds.

Allowing that these hides averaged 25 pounds apiece, the rail shipments for the past ten years would show a total of 1,492,100 hides, making, with those sent by water, a total of 1,834,800, against a total of 1,455,400 by water and by rail in the previous ten years. These hides have been worth from $3 to $4 apiece, as a rule.

Averaging them all at $3 50 apiece, this branch of our export trade for the past 26 years amounts to $16,947,400, of which $11,515,700 is the result of the past 20 years.

BAGS AND BURLAP.

SOME FACTS ABOUT THE GRAIN-SACK TRADE—A SEVERE TAX ON FARMERS—WHY CALIFORNIA WHEAT CANNOT BE SENT TO EUROPE IN BULK—THE DUTY ON JUTE.

Among the many taxes laid upon the farmer not the least is the cost of grain bags. The grain-growers of California do not spend less than $2,000,000 annually for this purpose, which is one that brings no return; for grain in this State is exported in bags, and not in bulk, as in the Eastern States. With high rates of ocean freight, the burdens upon our agriculturists are so great that of the many millions of dollars realized for the grain crops of this State, but few find their way into the pockets of the farmers. The grain-sack question has been considerably agitated among the grangers, especially during harvest seasons, when the importers and speculators, with the aid of corners, inflate the price of the commodity almost 100 per cent. It has often been asked why wheat, barley, and other grains, which is sent across the Atlantic in bulk, cannot be shipped in the same manner from San Francisco.

A little reflection will show that there is a vast difference between sending grain in bulk across the Atlantic, a passage occupying but fourteen to twenty days, and a long voyage through one of the roughest seas of the world—that off Cape Horn—a trip which never consumes less than ninety and often consumes the better part of one hundred days.

Were grain shipped in bulk around Cape Horn, it is safe to say that about 15 per cent of the vessels so laden would be foundered, and that the cargo of an equal number would be completely damaged.

LOADING OF GRAIN.

The danger of shifting cargoes is even a greater one than the most violent hurricane, and careless stevedoring and freighting have sent more sailors to Davy Jones' locker than any other agency. The men engaged in the wheat export trade, and particularly those in marine insurance, have profited by the experience, in consequence of which one of the main requirements of good merchantable wheat now is that it shall be contained in new jute bags. The loading of vessels has become a special branch of the export business, and no vessel or cargo can be insured unless the Captain can produce a certificate from the Underwriter's Surveyor that the cargo has been stowed in a proper and safe manner. It may not be generally known that each cargo requires from $250 to $350 worth of redwood lumber for "dunnage" planks, which are laid across the timbers of the ship, as the contact of the grain with the timbers during the long voyage would spoil the grain. That the necessity of carrying grain in sacks is not assumed, but real, is proved by the many adverse criticisms which have been pronounced against the system of carrying it in bulk, which is in vogue at Atlantic seaports, for, though the voyage is short and its dangers less great, the number of losses from shifting cargoes is disproportionately great. It can safely be asserted that there is no port in all the world where the percentage of disasters from that cause is smaller than that of San Francisco. The average of loss of grain vessels out of an annual total of from 300 to 400 dispatched from this point is about three. The rates of marine insurance have been proportionately decreased, and it is certain that should the attempt to ship grain in bulk ever be made, the advance in these rates would be fully as large as the cost of grain bags.

THE BAG BURDEN.

The grain producers need therefore entertain no hope that they will ever be relieved from the bag burden by a change of the mode of shipment. It is nevertheless true that the burden is unjustly onerous and that it ought to be abated if possible, notwithstanding the fact that there have been no effective corners during the past three years, and bags at the present day can be bought at less than import cost. The sources from which California draws her supply of bags are India and Scotland, the places of shipment being Calcutta and Dundee. The imports from the latter port, however, have dwindled down to an inconsiderable amount, and the India bags virtually rule the market. But these imports are not always in the shape of bags. Quite a large quantity comes as jute, the material out of which bags are made.

Upon this the Government levies a 25 per cent ad valorem duty to foster and protect the jute-growing industry in the United States.

There is at the present moment but one establishment in this State at which this jute is manufactured into grain bags. This is the factory at the State Prison in San Quentin, where operations, though commenced but a short time ago, have been eminently successful, netting a monthly profit of from $4,000 to $5,000. There was a bag manufacturing establishment at East Oakland up to October last. This was the Pacific Jute Company's mills, a concern which succumbed after a long struggle for fair profits. Lately it has passed into other hands, and now, under the name of the "California Jute Company," another attempt is to be made to make the weaving of burlap successful.

THE DUTY ON CLOTH.

The Government encourages the industry by levying an import of 30 per cent ad valorem upon the cloth, in which shape another moiety of the imports reaches this port. There are four factories in this city and six in the interior in which the sewing of bags out of burlap is carried on. The work gives employment at busy seasons to not less than 300 women and girls. But by far the greater part of supply comes in the shape of bags ready made, and that despite the fact that the Government discriminates against them by levying a duty of 40 per cent ad valorem upon them.

Viewed in connection with the protective tariff, the problem of cheaper bags presents difficulties. That the duties increase the cost of bags to the farmer at the rate of about two and a half cents each is plain. But this duty is levied for the triple purpose of encouraging the raising of jute, the weaving of burlaps, and the sewing of bags. It seems to be taken for granted that Congress will not reduce these duties, although it falls short of its intended purpose. For years past the imported ready-made bags have commanded a much higher price than those manufactued at the Oakland mill, and although the latter company has persistently and largely undersold the importer, the consumers seem to have been willing to pay rather an advance for the Calcutta made article than use the home-made product.

What the possibilities of jute culture are in this State does not seem to have as yet been determined. The Prison Commissioners have taken a lively interest in encouraging the raising of the plant, but so far, their efforts have not met with practical success.

At best, the price of bags, even should jute be successfully raised in this State, would be reduced only by so much as corresponds with the difference between the cost of imported and home-made jute, for the San Quentin factory has need of the tariff rate, and the resulting market price of bags, in order to enable it to compete with the Calcutta mills.

PRICE OF SACKS.

As matters now stand it costs on an average about 8 cents to lay a bag manufactured in Calcutta down in San Francisco, duty paid, and as the market price now ranges from $7\frac{5}{8}$ to $7\frac{3}{4}$ cents, it follows that under the present state of affairs somebody is losing money, while the farmer is getting his bags below cost price. It is not necessary to discuss here the causes which have led to this decline in the market, for they are not local only.

California, with an expected wheat surplus of 1,200,000 tons, will require 30,000,000 bags, and Oregon will require about 6,000,000 more. Yet, with this great demand before them, the importers and holders have been unable to control the market, and the farmer reaps the benefit. There are few commodities which have been subject to so many and so great fluctuations, generally produced by local and speculative causes.

Grain bags have been a favorite article of trade in which to make "corners," and few years have passed which have not witnessed an attempt in that direction. The last was in July, 1881, when the market price reached $10\frac{1}{2}$ cents. The highest price since 1876 was $14\frac{3}{4}$ cents, obtained in October, 1878, and the lowest was paid about a month ago, bags then changing hands at 7 cents each.

LUMBER EXPORT TRADE OF CALIFORNIA.

The two principal export products which the argonauts found in California upon their arrival were gold and lumber. These were indigenous to the soil. Gold was the most available of the two, because it was ready for export the moment it was washed from the sands in the dry river beds, whereas the trees must be felled and the logs sawed into boards before lumber could be exported; and sawmills were not very plentiful in this State in the pioneer days. But in both cases the raw material was here in abundance, and without any previous care or labor on the part of those who found them, and who had come to take possession of them. We have not the date of the first exports of lumber from California. Of course in pioneer days the hunt for gold had the preference. Men lived in tents or sent East for houses in frame all ready to put up on arrival, rather than be at the trouble and expense of getting out lumber from the forests of the State. But in course of time it was found that there was wealth in the trees along the river banks as well as in the sands of the river beds, and the sawmill was erected and the work of preparing lumber for the market commenced.

The lumber exports from California by sea for the past twenty years have been as follows in M feet, board measure:

Years.	M Feet.	Years.	M Feet.
1864	10,681	1874	9,036
1865	12,580	1875	10,024
1866	7,825	1876	10,781
1867	5,735	1877	13,874
1868	7,602	1878	14,598
1869	8,509	1879	16,501
1870	13,680	1880	14,371
1871	17,591	1881	18,269
1872	16,517	1882	22,094
1873	17,415	1883	14,876

As will be seen, there were moderate shipments in from 1866 to 1869, both years inclusive, and again in 1874. Otherwise the annual exports by sea have never fallen below 10,000,000 feet, while in 1882 the total was over 22.000,000 feet. The quantity shipped for the past twenty years is 262,559,000 feet, divided between the first and second decade as follows:

1864–73	118,135,000
1874–83	144,424,000
Total feet	262,559,000

Some of this lumber has been manifested as high as $30 per M feet, and some as low as $10. Perhaps a fair average right through the whole period for all sorts would be $20 per M feet, which would give a value of $5,251,200 for the trade.

In addition to the exports by sea, there has been more or less lumber shipped overland by cars in the past ten years. There were shipments of lumber from Sacramento to the east by rail as early as 1871, or within two years after the opening of the road. The first shipments by rail from San Francisco were made in 1873, and continuously every year since. These shipments have never been large, and being reported by weight, it is hardly worth while to follow them. The principal markets that draw upon us for lumber are Australia, China, and South America. There have also been free shipments to Central America and Mexico, as well as to the Hawaiian, Society, and other islands in the Pacific. We have sent occasionally small consignments of lumber to Europe for many years, and have also sent some small lots to New York by sea in the last ten years. Besides boards, we have exported a good many laths, shingles, and other forms of lumber to various parts of the world for a long time. We have also sent considerable consignments of doors, blinds, window sash, and moldings to Australia from year to year. In one form or another, the lumber exports from California for the past twenty years have been nearer $10,000,000 than $5,000,000.

The redwood forests are peculiar to California. These commence at the northern coast boundary of the State, and run out just this side of Lower California on the extreme southern coast boundary. Why Providence has given to California the only known redwood forests of the world, is a circumstance for scientists to investigate. According to the census of 1880, the quantity of redwood in California was 25,825,000,000 feet, board measurement, while the same authority gives the amount cut during the year ending May 31, 1880, at 186,635,000 feet, board measurement. At this rate of consumption, the redwood forests of this State will not last many years, unless efforts are made to keep them renewed. During the Summer of 1883, some Scotch capitalists purchased from 50,000 to 60,000 acres of redwood forests in Humboldt County, and organized the California Redwood Company, full particulars of which were given in the *Bulletin* September 7, 1883. The first full cargo of redwood for Europe was cleared from San Francisco January 27, 1883; the second November 30, 1883; the third January 14, 1884; and the fifth February 23, 1884, the four vessels carrying 2,006,000 feet, valued at $47,600. The Prince Rupert is now loading a cargo of lumber for London on the same account.

While the quantity of lumber shipped from California is comparatively small, it should be remembered that the large lumber interests in Oregon and Washington are practically controlled by California capitalists. Most of the orders for lumber for Australia, China, and South America are received in San Francisco, but the vessels are loaded at the mill ports at the north, at Eureka, on the California coast, and in the Columbia River and on the Sound. We have not the details of this trade at hand for the past twenty years, but it must foot up many millions in money, a good proportion of which properly belongs to the export trade of California, but as the vessels were not cleared in this customs district, the values cannot be legitimately credited to San Francisco. The large supplies annually consumed in this city and around the bay are mainly obtained from Oregon and Washington Territory. Despite the fact that scores of mills have been decimating these forests at the north for many years at a fearful rate, the number of trees removed has made but little impression on the supply. In 1883 there was received at San Francisco 276,000,000 feet of lumber, 135,000,000 shingles, 90,000,000 laths, 1,600,000 railroad ties, besides a large quantity of minor descriptions.

CHAPTER XI.

THE EIGHT-HOUR LAW.

The question as to what shall constitute a day's work is one that is yearly pressing itself upon the attention of the country, and which must sooner or later be definitely answered.

Already the balance of opinion seems to be in favor of what has been called "short hours and long pay." Upon this subject Joseph Medill, of the Chicago *Tribune*, who has given much attention to the labor question, made the following statement before the Senate Committee on Education and Labor, September 26, 1883. It is of course understood that these are Mr. Medill's opinions, and I quote them without indorsement:

"SHORT HOURS AND LONG PAY."

It is a standard belief in trades union lodges that the ills of labor would be relieved in great degree by shortening the day's work to six or eight hours, as it would cut down production per man twenty-five or forty per cent, thus creating a great demand for extra labor, which, in turn, would force up wages to a high point, say twelve hours' pay for eight hours' work, or fourteen hours' pay for six hours' work. And it is alleged and contended that nothing stands in the way of the adoption of this scheme of long pay for short work, except the unfeeling selfishness of employing capitalists. In my opinion, this idea to get a "corner" on the labor market would prove delusive, and fail utterly, if tried; and for these reasons: increased wages for short work would instantly attract to this country countless multitudes of foreign workmen. They would rush hither as fast as fleets of steamers could bring them, and quickly swamp the demand for extra labor caused by short work. In a little while they would be soliciting employment at reduced wages, and offering to work for ten hours a day for probably half the pay that had at first been demanded for six hours' work, and this by reason of the over-supply of labor. But the panacea would fail to cure from the operation of another cause. It is axiom that "dear labor makes dear goods." The effect of large wages and small work would be to greatly increase the cost of production and the price of manufactures in proportion to the enhancement of labor prices; the demand for such goods would necessarily decline, because the remainder of the community cannot afford to buy as large a quantity of artificially dear fabrics. Rents, too, would advance in the same degree that the cost of building houses increased, and the number of new structures would greatly decline, and that would cut off labor. Merchants would refuse to buy the excessively dear domestic goods produced under these circumstances, but would import what merchandise they needed, and if the trades unionists undertook to double up the tariff, in order to prohibit importation, the great agricultural masses would sternly resist being thus fleeced for the benefit of any city classes of producers.

The farmers constitute one full half of the American people, and they furnish one full half of the market for the productions of the town. Their power to buy domestic goods is limited strictly to the amount of money they receive for their crops. The cheaper goods are, the more the farmer can purchase, and conversely, the dearer, the fewer. The trades-union idea of short work and long pay would cut off a large part of this market provided by the farmers, leaving their dear goods unsold, and this would result in throwing multitudes of workmen out of employment and on to the streets; the farmers cannot be overcharged by the town artisans without the latter being punished for it by loss of market. This is a law of trade which the framers of our tariff are apt to overlook, and the railroad magnates who are practising the principle of charging for freight and fare "all that the tariff will bear," will do wisely to reflect, that the higher their tolls are on agricultural products the less return freight or general merchandise they will carry, because their extortion will cripple the farmer's ability to pay for goods or travel on their roads. Fleecing the farmers is not the best policy on the part of either the manufacturers or the railroads.

The arguments Mr. Medill makes use of are, it will be seen, altogether one-sided, and I only give them space from a desire to present you with what has been said for and against the scheme of shortening the hours of labor. A much fairer consideration of the subject is that which was made by William J. Noble, of New York City, in a pamphlet which, for its concise and plain presentation of the subject, meets my approval, and will, I am sure, commend itself to your favor:

Believing that the "depression of trade," and also the "eight-hour movement," are the two important issues of the day, I claim that the enforcement of the latter is the only direct relief for the former, inasmuch as the markets are glutted with all kinds of goods, and still manufacturers and corporations, in their blind cupidity, speed their machinery to its utmost capacity ten hours per day, exciting competition, cheapening goods, and reducing prices until the manufacturing of staple goods affords no profit, from which condition they invariably seek relief by a further reduction of wages, which is generally followed by strikes and the shutting down of mills. Yet, as consumption continues during these suspensions of production, demand naturally gains a stride toward an equilibrium with supply; but soon necessity compels labor to resume work at reduced wages, and again on goes over-production, with the advantage to capital of a more firm market and cheaper labor. In this regard strikes generally terminate to the advantage of capital and detrimental to labor. But as a natural consequence, when supply is in excess of demand, the markets are soon again glutted, many merchants necessitated to disgorge at ruinous prices, and trade and labor are depressed by the many evils that naturally follow such a state of affairs.

All these, I claim, are the natural consequences of our over-production, which has emanated from the introduction of improved machinery and other labor-saving and fast-producing facilities, of which the capacity for production have reached a stage when it is evident we can no longer (in keeping with the law of supply and demand) provide ten hours per day remunerative employment to all who depend upon employed labor for their living. And if capital and labor are to hold an equality of dignity, we must necessarily make a further retrenchment of labor—to, say, eight hours per day; for so long as capital lays claim to control labor, so long is it but just for labor to claim that capitalists should be wise and generous enough to study the laborers' interests as well as their own.

Although all wealth emanates from labor, yet labor should not be unreasonable in its demands on capital; for as there can be no mutually satisfactory arrangement instituted that is not mutually beneficial to both capital and labor, it is essential that capital and labor should alike understand how a retrenchment of labor to eight hours per day would affect respective interests:

First—Contemplating the effects the proposed retrenchment of labor would naturally have on capital, we would be relieved from over-production and the constant fluctuations of prices which are caused by alternate over-production and suspensions. We would have a more regular and better demand for our productions, firmer and steadier markets, confidence in commercial interests would be restored, and prices would advance until they attained a standard 20 per cent higher than present prices. This would be the natural consequence of the retrenchment of labor to eight hours per day, consequently labor would likewise advance 20 per cent above its present standard. As the value of supply is estimated by demand, the retrenchment of labor and production from ten to eight hours would enhance the value of the same as ten is to eight, and as it would afford capital steady business it would also afford labor steady employment, and thus be a mutual benefit to capital and labor.

In contemplating labor as it would be affected by the proposed retrenchment, we encounter an obstacle at the outset, inasmuch as it is necessary in order to insure the general adoption of eight hours as the standard day's work, a sacrifice must be made, either by capital or labor, or both; but, knowing the nature of man, the perversity of those who govern, and that the dominant spirit of avarice, cupidity, and self is strongest in wealth and capital, hence I despair of the success of an appeal to capital to make the sacrifice. Nor is it best or just that capital should make the sacrifice, for under the present state of affairs capital cannot remuneratively pay for eight hours' labor; consequently, if labor would enjoy the benefits that must naturally follow the retrenchment, some labor must lead in the movement, and institute eight hours as the standard day's work, by submitting to a reduction of 20 per cent in wages.

This reduction of wages will at the outset have a tendency to discourage many low wage operatives and laborers from joining in the eight-hour movement; but all such should remember that it would be only for a short time that they would be required to accept the reduced wages, for as soon as the present stock of goods in the market produced under the ten-hour system was turned in the hands of consumers (which would require but a few months) then would prices and consequent wages advance, as I have stated, to 20 per cent more than you now get for ten hours.

As this is a rule that is best understood by experience, we will refer to the time when fourteen hours constituted a day's work, and the wages that were then paid to skilled and unskilled labor throughout America and Europe. Note the improvement in trade and the advance of wages that followed the change from fourteen to twelve hours as a day's work. And, again, the happy result of the change from twelve to ten hours as the standard day's work, when wages within a short time advanced twenty-five per cent; and now that the improved facilities employed in the manufacture of all kinds of goods have so increased our productions that we now find it necessary to make a further retrenchment of labor to eight hours per day, and, when once started, will soon become general throughout the country in all manufacturing business. One of the grounds of objection taken by capitalists against the eight-hour movement is that it would kill our export trade. This, however, is too sweeping a claim, since it could only materially affect our export trade in cotton goods; and when we consider the small portion of these goods that we export, and the strenuous effort it requires of capital and labor to compete for this, I doubt if it is a benefit to us, when we know that an advance of cotton goods of two cents per yard would not affect the poorest woman in buying a calico dress, and would be a benefit to the capital and labor employed in that industry, as seven is to five, and while we do no more expect the agriculturists and many other vocations to observe the eight-hour standard than they now observe the ten-hour standard day's work; consequently, the retrenchment could have no effect on our export trade in beef, cheese, butter, hops, wheat, and cotton. Even England did continue to work ten hours per day, but we have reason to know that England would gladly follow us in the eight-hour movement.

As to the prophecy of drunkenness, we know the reverse. Statistics and experience prove that constant work for long hours, or over-exertion, causes exhaustion, and creates a desire for strong artificial stimulants (such as alcoholic liquors), produce mental incapacity, general insensibility, grossness of feeling and perception, with disease and shortened life. That the intelligence of the working classes would improve with the advantage of more leisure time we have every reason to believe, and that political tricksters and shameless demagogues could no longer turn their ignorance to the advantage of political party power. They would better understand the causes of their evils and the remedies they ought to apply, and instead of considering machinery a detriment to labor, they would realize it as the greatest benefit to them, exactly as the elements of fire and water can be made beneficial or injurious to us just as we put ourselves in right or wrong relations to them. It has been computed, says Dr. Franklin, that if every man and woman would work four hours each day on something useful, that labor would be sufficient to procure all the necessaries and comforts of life; want and misery would be banished out of the world, and the rest of the twenty-four hours might be leisure and pleasure; but as Dr. Franklin computed one hundred years ago, with our present facilities, were it possible for all to perform their share of useful work, two hours would suffice.

The preceding pamphlet was read before the Senate Committee on Education and Labor, and was, by the Chairman, accepted as a strong argument in favor of the eight-hour law, and as such, I am quite willing to leave it with you.

In looking over the factory laws of the different States, I find that the Legislature of New Hampshire has provided, that "no person shall be employed more than ten hours per day, except in pursuance of express contract requiring longer time."

Massachusetts provides that the hours of labor shall not exceed sixty in a week.

Rhode Island has legislated that, "ten hours' work in any one day constitutes a legal day's work, unless otherwise agreed by the parties to the contract for same."

Connecticut provides that "eight hours constitute a legal day's work, unless otherwise agreed upon."

New York says plainly that "eight hours constitute a legal day's work, except for farm and domestic labor. Overwork for extra compensation is permitted."

New Jersey has provided that "ten hours per day constitute a legal day's work in all cotton, woolen, silk, paper, glass, and flax factories, and in manufactories of iron and brass."

Pennsylvania's laws provide that "eight hours constitute a legal day's work, in absence of special contract, except for farm labor and labor by the year, month, or week. Ten hours constitute a legal day's work in cotton, woolen, silk, paper, bagging, and flax factories."

Illinois has a law that "eight hours of labor constitute a legal day's work in all mechanical trades, arts, and employments, and other cases of labor and service by the day, except in farm employments, or where there is no special contract or agreement to the contrary."

You will see by the foregoing abstracts that the subject is no new one in the halls of legislation. You will have seen also by the remarks made by the workingmen themselves, which are quoted in Chapter VI, that the wish to have a curtailment of hours is almost without exception.

In the press of my other duties in connection with the bureau, I have not been able to give this subject all the attention it deserves, but I propose during the coming year to make this question one of thorough investigation, and in my next report will present you with the result of my researches and the recommendations I deduce from them. I feel, however, that I should not have done my duty had I omitted the above preparatory reference to a subject of which I am anxious you should appreciate the importance.

For the benefit of such members as are interested in the subject of labor legislation I append a brief summary of the factory laws of the different States, which will indicate to what extent the principles of English factory legislation have been adopted in America. The States named are the only ones in which factory laws exist:

Maine.—No child can be employed or suffered to work in a cotton or woolen manufactory without having attended a public or private school, if under the age of twelve years, four months; if over twelve and under fifteen years of age, three months of the twelve next preceding such employment each year. A teacher's sworn certificate of attendance, filed with the employer, constitutes the proof of schooling. A fine of $100 is imposed for a violation on the part of the employer of the provision of the law.

No person under the age of sixteen years can be employed by any corporation more than ten hours a day. The penalty for violating this provision is $100.

Factories more than two stories in height, where workmen are employed above the first story, must be provided with outside fire escapes satisfactory to municipal officers. (See Chap. 48, Revised Statutes; Chapter 221, Acts of 1878; Chapter 49, Acts of 1880.)

New Hampshire.—No child under fifteen years of age shall be employed more than ten hours per day, without written consent of parent or guardian. No person to be employed more than ten hours per day, except in pursuance of express contract requiring longer time. No child under ten to be employed by any manufacturing corporation. Children under sixteen not to be employed in factories unless they have attended school twelve weeks during preceding year; and no child under said age shall be employed (except in vacation time) who cannot write legibly and read fluently in the readers of the third grade. No child under fourteen to be employed unless he has attended school six months, or the school of his district the whole time it was kept; and no child under twelve who has not attended the school of his district the whole time it was kept. (See General Statutes, Chapter 187; Chapter 21, Acts of 1879; Chapters 42 and 56, Acts of 1881.)

Vermont.—Children under ten not to be employed at all; under fifteen, not more than ten hours per day; between ten and fifteen, not to be employed in mill or factory unless they have received three months' schooling the preceding year. (See General Statutes, Chapters 40 and 202.)

Massachusetts.—No child under ten years of age shall be employed in any manufactory, mechanical, or mercantile establishments in the commonwealth. No child under fourteen years of age shall be so employed, except during the vacations of the public schools, unless during the year preceding such employment he has, for at least twenty weeks, attended some public or private day school; nor shall such employment continue unless such child in each and every year attends school as aforesaid; and no child shall be so employed who does not present a certificate, made by or under the direction of the school committee, of his attendance at school as provided.

Employers shall require and keep on file a certificate of the age and place of birth of every child under sixteen years of age employed and the amount of his school attendance during the year next preceding such employment. The penalty for employment of children, contrary to these provisions, is not less than $20 nor more than $50. Truant officers are obliged to visit establishments and inquire into the situation of the children employed, and may demand the names of children and the certificate of age and school attendance. Children under fourteen years of age who cannot read and write are not to be employed while public schools are in session; parents or guardians permitting such employment are subject to a fine of not less than $20 nor more than $50.

Employers requiring from employés, under penalty of forfeiture of wages earned, a notice of intention to leave, shall be liable to like forfeiture if employé be discharged without similar notice.

Whoever, by intimidation or force, prevents or seeks to prevent a person from entering into or continuing in the employment of a person or corporation, shall be punished by a fine of not more than $100.

Employers are not to contract with employés for exemption from liability for injuries resulting from employer's own negligence.

No minor under eighteen years of age and no woman shall be employed in laboring in any manufacturing establishment more than ten hours in any one day, except when it is necessary to make repairs to prevent the interruption of the ordinary running of the machinery, or when a different apportionment of the hours of labor is made for the sole purpose of making a shorter day's work for one day of the week; and in no case shall the hours of labor exceed sixty in a week. The penalty for a violation of this provision is not less than $50 nor more than $100.

The belting, shafting, gearing, and drum of all factories, when so placed as to be dangerous to persons employed therein while engaged in their ordinary duties, shall be, as far as practicable, securely guarded. No machinery, other than steam engines, in a factory, shall be cleaned while running, if objected to in writing by an inspector. All factories shall be well ventilated and kept clean. The openings of all hoistways, hatchways, elevators, and well-holes upon every floor of a factory or mercantile or public building, shall be protected by good and sufficient trap-doors or self-closing hatches and safety-catches. All elevator cabs or cars shall be provided with some suitable device for securely holding the cabs in case of accident to the hoisting machinery.

All manufacturing establishments, three or more stories in height, in which forty or more persons are employed, unless supplied with a sufficient number of tower stairways, shall be provided with sufficient fire escapes, properly constructed upon the outside thereof, and connected with the interior by doors or windows, with suitable landings at every story above the first, including the attic, if the same is occupied for workrooms. Such fire escapes shall be kept in good repair and free from obstruction.

Every room above the second story in factories or workshops in which five or more operatives are employed shall be provided with more than one way of egress, by stairways on the inside or outside of the building; and such stairways shall be, as nearly as may be practicable, at opposite ends of the room. Stairways on the outside of the buildings shall have suitable railed landings at each story above the first, and shall connect with each story of the building by doors or windows opening outwardly; and such doors, windows, and landings shall be kept at all times clear of obstruction. All main doors, both inside and outside, must open outwardly, and each story must be amply supplied with means for extinguishing fires.

Every building three or more stories in height, in whole or in part used for a tenement for more than four families, or a lodging house, shall be provided with a sufficient means of escape in case of fire. No explosive or inflammable compound shall be used in any factory in such place or manner as to obstruct or render hazardous the egress of operatives in case of fire.

Persons violating these provisions as to buildings are liable to a fine of not less than $50 nor more than $100. Females employed in manufacturing establishments must be provided with seats, and be permitted to use them when not engaged in the duties for which they are employed. This also applies to stores.

For the enforcement of all these provisions the Governor appoints two or more members of the district police (a State force) to act as inspectors of factories and public buildings. They may enter all buildings used for public or manufacturing purposes, examine methods of protection from accident, means of escape from fire, and make investigations as to the employment of women and children. Fire escapes, etc., are to be constructed under the approval of one of the inspectors. (See Chaps. 48, 74, 103, 104, Public Statutes; and 150, 208, 266, Acts of 1882.)

Rhode Island.—No child under twelve years of age can be employed in any manufacturing establishment; no child under fifteen, unless he has attended school at least three months the preceding year; and no such child shall be employed for more than nine months in any year. No child between twelve and fifteen years of age shall be employed in any factory more than eleven hours in any day, nor before five o'clock in the morning, nor after half-past seven in the evening. The violation of these provisions is punished by fine of $20. Ten hours' work in any one day constitutes a legal day's work, unless otherwise agreed by the parties to the contract for same. Town and city councils may pass ordinances requiring fire-escapes on factories in which workmen are employed above the second story. (See General Statutes, Chap. 38.)

Connecticut.—No child under fourteen shall be employed in any business, unless such child shall have attended some day school for sixty days during preceding year, six weeks of such attendance to be consecutive. It is the duty of "school visitors," in every town, once or more in each year, to examine into the situation of children employed in manufacturing establishments to see if provisions of law are complied with. Parents and guardians must send children to school the legal time; violation punishable by fine of $5 for each week's neglect.

Employer of child under fourteen must have a certificate of child's attendance at school according to law. No child under fifteen to be employed in factories more than ten hours per day, or fifty-eight hours per week, under penalty of $50.

Each story above the second story of factories and workshops must be provided with more than one flight of stairs inside, or outside fire escapes, satisfactory to Selectmen or Fire Marshal of town.

Eight hours constitute a legal day's work, unless otherwise agreed upon. (See General Statutes, Title 14, Chapter 6; Chapter 37, Acts of 1880; Chapter 80, Acts of 1882.)

New York.—Children under fourteen are not to be employed during school hours unless they have attended school at least fourteen weeks during year preceding; the employer to have certificate of such school attendance. Eight hours constitute a legal day's work, except for farm and domestic labor. Overwork, for extra compensation, is permitted. (See Chapter 385, Laws of 1870; Chapter 421, of 1874; and Chapter 372, of 1876.)

New Jersey.—No child under ten years of age shall be admitted to work in any factory; and no minor shall be holden or required to work more than ten hours on any day or sixty hours in any week; penalty for violation of latter provision is $50. Ten hours per day constitutes a legal day's work in all cotton, woolen, silk, paper, glass, and flax factories, and in manufactories of iron and brass. (See Acts of 1851, Chapters 17 and 18.)

Pennsylvania.—Eight hours constitute a legal day's work, in absence of special contract, except for farm labor and labor by the year, month, or week. Ten hours constitute a legal day's work in cotton, woolen, silk, paper, bagging, and flax factories. No minor under thirteen shall be employed in any such factory under penalty of $50. No child between thirteen and sixteen years of age shall be employed more than nine months in any one year, who shall not have attended school at least three consecutive months in the same year. No minor shall by any contract be employed in any of said factories for more than sixty hours per week, or an average of ten hours per day. Penalty for violation of this provision not to exceed $50. Factories in which employés are at work in third or higher story, must have permanent external fire-escapes, satisfactory to Fire Commissioners and Fire Marshal of district. (See Acts of 1849, 1868, 1879.)

Maryland.—The law prohibits the employment of children under sixteen years of age in factories for more than ten hours per day, under penalty not exceeding $50.

Ohio.—No child under fourteen shall be employed in mills or mines during school hours, unless he has received at least twelve weeks' schooling during the year preceding, and employers must have certificate to that effect; two weeks' attendance at a half-time or night school to be considered equivalent to one week at a day school. Whoever compels a woman, or a child under eighteen, or permits a child under fourteen, to labor in a mechanical or manufacturing business more than ten hours per day, shall be fined not less than $5 nor more than $50. (See Revised Statutes, Sections 4023, 4024, 4029, 6986.)

CHAPTER XII.

SCHOOL STATISTICS.

The following report was furnished this office by the State Superintendent of Public Instruction:

State of California—Department of Public Instruction.

Office of State Controller,
Sacramento, August 3, 1883.

Hon. W. T. Welcker, *Superintendent Public Instruction:*

Sir: In compliance with an Act of the Legislature, I have the honor to report as follows:

The securities held in trust for the School Fund by the State Treasurer, consists of bonds of the State of California, amounting to one million seven hundred and thirty-seven thousand five hundred dollars ($1,737,500), together with bonds of different counties of this State, aggregating two hundred and forty-one thousand four hundred dollars ($241,400), which are described as follows:

State Capital Bonds, 1870—seven per cent	$236,000 00	
State Capital Bonds, 1872—seven per cent	115,000 00	
State Funded Debt Bonds, 1873—six per cent	1,386,500 00	
		$1,737,500 00
Humboldt County Bonds—nine per cent	$25,000 00	
Mendocino County Bonds—eight per cent	10,000 00	
Napa County Bonds—seven per cent	60,000 00	
Sacramento County Bonds—six per cent	26,400 00	
San Luis Obispo County Bonds—eight per cent	50,000 00	
Santa Barbara County Bonds—ten per cent	20,000 00	
Solano County Bonds—seven per cent	9,500 00	
Stanislaus County Bonds—eight per cent	9,000 00	
Tehama County Bonds—eight per cent	11,500 00	
Tulare County Bonds—ten per cent	20,000 00	
		241,400 00
Total securities held in trust for the School Fund		$1,978,900 00

On July 24, 1883, there was called in and redeemed from the securities held in trust for the School Fund, Solano County Bond, No. 6, amounting to $500, the proceeds of which have been paid into the State School Land Fund, to be reinvested in other bonds.

The money in the State Treasury belonging to the State School Fund, subject to apportionment, is three hundred and ninety-one thousand thirteen and sixty-five one hundredths dollars ($391,013 65), as follows:

Balance unapportioned February 16, 1883		$748 89
Received from property tax	$132,489 69	
Received from State poll tax	177,508 17	
Received from interest on bonds held in trust	59,276 50	
Received from interest on State school lands	22,650 48	
		391,924 84
		$392,673 73
Paid restitution of interest on State school lands not the property of the State	$1,088 51	
Paid cost of collecting interest on State school lands	571 57	
		$1,660 08
Total amount subject to apportionment August 3, 1883		$391,013 65

JOHN P. DUNN, Controller.

Office of Superintendent of Public Instruction,
Sacramento, August 7, 1883.

In accordance with the foregoing statement of the Controller, I have this day apportioned the State school money to the several counties as follows:

Number of census children between five and seventeen years of age entitled to receive school money, 222,846; *amount per child,* $1 75; *amount apportioned,* $389,980 50.

Counties.	No. Children.	Amount.	Counties.	No. Children.	Amount.
Alameda	17,376	$30,408 00	Sacramento	8,121	$14,211 75
Alpine	92	161 00	San Benito	1,603	2,805 25
Amador	2,815	4,926 25	San Bernardino	3,117	5,454 75
Butte	3,982	6,968 50	San Diego	2,221	3,886 75
Calaveras	2,194	3,839 50	San Francisco	58,061	101,606 75
Colusa	3,089	5,405 75	San Joaquin	5,829	10,200 75
Contra Costa	3,382	5,918 50	San Luis Obispo	2,844	4,977 00
Del Norte	458	801 50	San Mateo	2,434	4,259 50
El Dorado	2,287	4,002 25	Santa Barbara	3,455	6,046 25
Fresno	2,985	5,223 75	Santa Clara	9,487	16,602 25
Humboldt	4,149	7,260 75	Santa Cruz	3,972	6,951 00
Inyo	518	906 50	Shasta	2,326	4,070 50
Kern	1,347	2,357 25	Sierra	1,133	1,982 75
Lake	1,556	2,723 00	Siskiyou	1,847	3,232 25
Lassen	841	1,471 75	Solano	4,975	8,706 25
Los Angeles	12,428	21,749 00	Sonoma	7,572	13,251 00
Marin	2,177	3,809 75	Stanislaus	2,098	3,671 50
Mariposa	995	1,741 25	Sutter	1,349	2,360 75
Mendocino	3,534	6,184 50	Tehama	2,521	4,411 75
Merced	1,374	2,404 50	Trinity	677	1,184 75
Modoc	1,191	2,084 25	Tulare	3,646	6,380 50
Mono	503	880 25	Tuolumne	1,670	2,922 50
Monterey	3,513	6,147 75	Ventura	1,607	2,812 25
Napa	3,281	5,741 75	Yolo	3,154	5,519 50
Nevada	4,990	8,732 50	Yuba	2,149	3,760 75
Placer	2,902	5,078 50			
Plumas	1,019	1,783 25	Totals	222,846	$389,980 50

W. T. WELCKER,
Superintendent Public Instruction.

Up to date, ending July 20, 1883, there were 687 teachers in the public schools of San Francisco, who received $638,637 53. Of these the pay-roll shows that—

155 teachers received from	$50 to $60 per month
288 teachers received from	60 to 70 per month
170 teachers received from	70 to 90 per month
613 teachers received from	50 to 90 per month

Nearly all the remaining teachers are either principals, vice-principals, or teachers in the high schools.

The average pay of the 687 teachers in the department, taking all the high salaries of the principals with the low of the primary assistants, does not exceed $960 per annum, or $80 a month. Excluding principals, 29 of whom receive $135 a month, and 16 from $175 to $200 a month, and excluding the teachers in the high schools, most of whom receive $160 a month, it will be found that the great mass of the teachers are paid an average of but $840 a year. The compensation of nine tenths of them ranges from $50 to $90 a month.

CHAPTER XIII.

MINES AND MINING.

The shrinkage of bullion production, and the partial subsidence of stock gambling, have, by many, been supposed to denote a corresponding decadence in the mining industries of California, than which nothing could be more erroneous, the business of mining for the precious metals having never been in a more healthful and generally satisfactory condition than it is at present. There are now over thirty thousand men engaged in this branch of business in the State, and it may safely be affirmed that a like number of laboring men cannot elsewhere be found who are as well paid for the work they perform as these California miners, their yearly earnings averaging over $500 per man. Of this force, which is making such liberal earnings, nearly one half are Chinamen, who, in defiance of the letter and purpose of the law, occupy our mineral domain and exhaust it of resources that were intended to be preserved as an inducement for the better races to come in and settle permanently on these gold-bearing lands.

The advocates of Chinese immigration have defended the presence of these Orientals here, on the ground that they were needed for the performance of certain menial and poorly paid kinds of labor which the whites decline to engage in. Fifteen thousand Mongolians betaking themselves to our placer diggings, discloses how very flimsy is the foundation on which this sort of argument rests. That we permit these pagans to so take possession of our mines and deplete them to the detriment of our own kind shows, too, how little ground there is for the charge of hostility to the Chinese so often and so ignorantly made against our people. The inhabitants of the mining districts might, at any time, drive these Chinamen from their claims and themselves take possession of them, were they so disposed, and yet nothing of the kind has ever been done or attempted. The truth is, our miners are much more tolerant towards this race than, under the circumstances, could be expected.

While the Chinese so confine themselves almost wholly to the placers, a large proportion of the whites are engaged in vein mining, either for gold or silver, the latter, which for the past year or two, has received much attention, promising to soon become a very important industry in California.

Of the bullion produced in this State last year, valued at $18,000,000, nearly $3,000,000 consisted of silver.

Besides so large a number of men mining for the precious metals, we have some eight or ten thousand engaged in other branches of mining and in pursuits connected therewith. Thus, we produce in California, annually, quicksilver to the value of $1,200,000; borax, a part of it being the product of Nevada, to the value of $500,000; iron, to the value of $500,000; copper, petroleum, salt, and various other minerals, and metals to the aggregate value of several million dollars.

What renders these several branches of mining of especial advantage to the State consists in the fact that most of the money expended in their prosecution is on account of labor.

The sustenance they afford other industries is also a matter of great economic importance. Withdraw all these men from mining, and set them to tilling the land, thereby converting them into growers, instead of consumers of agricultural products, and how damaging would the change prove to the California farmer; or set them to work in the factories and machine shops, and how disastrous would it prove all round—the operatives with less work to be done and more men to do it—the proprietors with more things to sell and fewer people to buy them.

It is to the interest of all then, that mining in all its branches should be fostered and encouraged, both as a means of absorbing labor and enlarging the market for its products.

THE STATE MINING BUREAU—NEED FOR AN INSTITUTION OF THIS KIND.

By reason of the rapid declension of placer mining in California, considerable numbers of men were, year by year, forced to abandon that business and engage in other pursuits. Owing to this condition of things, the necessity of developing the other mineral resources of the State and opening up new avenues for the employment of labor became early apparent. The sentiment that some action should be taken on the part of the State, calculated to promote these ends, first found expression in the law enacted in 1880, establishing the State Mining Bureau and the office of State Mineralogist, and, again, in the passage of an additional Act, two years later, creating the Bureau of Labor Statistics, the former designed to enlarge and diversify our productive industries, and the latter to further the interests of the producing classes. In the adoption of these measures, California takes the advanced position, that whatever most concerns the welfare of the masses ought to most concern the State, a doctrine that, practically carried out, makes the Government literally the servant of the people, which it ought to be in fact as well as in name.

It has been the mistake of California that she has, in times past, depended too much on the production of a few staples, such as gold, wheat, and wool, a policy that, steadily adhered to, inevitably results in the enrichment of the few and the impoverishment of the many, inasmuch as no community can prosper that is not largely self-sustaining in the matter of its smaller and more numerous wants. A failure to accomplish this has tended to greatly retard both the social and industrial progress of our people. California, for many years, sustained towards the older States of the Union a sort of colonial relationship, buying of them freely without having experienced much in the way of reciprocal advantage, a great deal of what she so bought having consisted of things that might and ought to have been made at home. This state of dependence not only tended to keep us poor, but, by discouraging domestic manufactures, tended to prevent us helping ourselves.

During the past few years, however, a considerable change has been wrought in this respect, so many new industries having been inaugurated of late, that California is able to make now a very fair showing as a manufacturing State.

She has also begun, meantime, to look more carefully after her store of the useful minerals and metals, a work that, under the conduct of Professor Henry G. Hanks, State Mineralogist and ex officio manager of the State Mining Bureau, is making good progress.

As this institution is likely to prove an efficient co-worker with the Bureau of Labor Statistics, some mention of its objects and operations may here very properly be made.

THE CREATION OF THE STATE MINING BUREAU—ITS OBJECTS, MANAGEMENT, AND WORK ACCOMPLISHED.

The law establishing the State Mining Bureau, among other things, provides that there shall be collected by the State Mineralogist and preserved for study and reference, specimens of all the geological and mineralogical substances found in the State, especially those possessing economic and commercial value, which are to be marked, arranged, classified, and described; it being made the duty of this official to collect as he may be able, and in a like manner preserve rocks, minerals, and fossils of other States, Territories, and countries; also, to make analytical assays as required; collect a library, procure models and drawings of mining machinery, correspond with schools of mining and metallurgy, visit the mining regions of the State and obtain information in regard to the same, and report on the whole to the Governor at the close of each year.

Professor Hanks since filling this double position, to which he was appointed by the Governor of the State, as the law provides, has discharged the duties pertaining to it ably and well, the State having received the full benefit of his long experience as a mineralogist, assayer, and analytical chemist. Professor Hanks is notoriously a worker—active, tireless, and thoroughly practical; as his time, his thoughts, his entire energies were formerly given to his profession, so are they now wholly devoted to the public service. He is zealous and enthusiastic in his calling without being at all visionary. What he has accomplished since holding his present position, will best appear from a brief recital of the history of the Mining Bureau, and its condition as we now find it.

THE MUSEUM.

The most noteworthy feature of this institution, located at 212 Sutter Street, consists of the extensive cabinet of mineral and other specimens, gathered mainly from California, but largely, also, from other parts of the world. Some of these specimens are very rare and all possess more or less value, as tending to illustrate the many forms of our natural wealth. This is the handsomest and probably the most valuable cabinet of the kind yet collected on the coast. Indeed, it is doubtful if anything more choice and varied has ever been gotten up elsewhere. It is, in fact, of such miscellaneous character, containing so much that is strange and curious as well as useful and instructive, that it has very properly been termed a *museum*. There is in this repository a great deal that relates to the arts and sciences as well as to geology, mineralogy, and other branches of natural history. These specimens, amounting now to over 6,000, have all been classified, labeled, and catalogued; the smaller and more interesting being displayed in large mounted glass cases, while the more bulky have been boxed up and stored away, there being in the present quarters no room for placing them on exhibition.

While so valuable, this cabinet has cost the State but little, the most of its contents consisting of gratuitous contributions or having been received in exchange for others sent to the donors, or else obtained by the State Mineralogist himself while visiting different parts of the country.

To whosever care this magnificent collection may come to be committed hereafter, it will be an easy matter to preserve it in good shape and continue its growth, now that all parts of it have been arranged with system and brought into good working order.

The similar collection owned by the State now deposited at Sacramento should, as soon as practicable, be removed to the city and be added to the museum of the Mining Bureau, where hundreds of appreciative visitors will see it for every one that will be likely to ever get a glimpse of it in the excluded and little frequented alcoves of the Capitol.

DIMINISHING REVENUES AND A DEPLETED EXCHEQUER.

The law creating the Mining Bureau provides that a fund for its support shall be raised by the imposition of a tax on all sales of mining shares made at the several stock boards. For a time the revenues derived from that source sufficed to meet the necessary expenditures of the institution. Soon, however, they began to fall off at a rate that caused its usefulness to become seriously crippled, and continuing to diminish, shrunk at last to proportions so small that some of the principal objects for which the bureau had been founded were necessarily defeated.

First, the chemist employed for the determination of minerals sent in for the purpose, had to be dismissed; next, the services of a janitor had to be dispensed with, and finally the Secretary had to be put on half salary, working for the bureau only on alternate days. To such strait has the head of the bureau been reduced that he can impart now only to a limited extent the information that the mining public, having been accustomed to receive, still continues to ask for and expect.

IMPORTANCE OF THE BUREAU, AND REASONS WHY IT SHOULD BE KEPT UP.

It is much to be regretted that this institution could not have received a support commensurate with its merits, seeing its aims are largely in the interest of the working classes. The prospector and miner, puzzled often as to the character of the minerals they meet with, and not able always to have the same accurately determined, found here just the aid and counsel they so much stand in need of. The time has come when the cheaper mineral products of the State ought to be utilized to a greater extent than has yet been done, and it is only fair that the public authorities should do something towards promoting that end. Many of these products are new to our people, who are not only ignorant of their character, but also of their economic value, and therefore require to be informed on all these points before attempting to mine or otherwise handle them. Some consist of base ores, the successful working of which involves skill and the employment of costly apparatus and difficult manipulations, such as parties should not engage in or undertake to provide without first taking counsel of some capable and thoroughly reliable adviser, such as the State can well afford and ought to supply. And in this connection it may be pertinent to observe that, while the State Mineralogist has in many cases been of great service to those seeking his advice, putting them on the road to success, so, on the other hand, has the information imparted by him saved many from engaging in enterprises that could result only in failure. In a country so new, and with a population so little experienced in searching after and judging of minerals, there is nearly as much need of a monitor to prevent the novice going wrong as to help him go right. A good deal of money has been lost in California through attempts made to utilize certain mineral products, simply because the business was gone about ignorantly.

Nevertheless, the fact stands that we ought to be exporters of more of these products than we really are. Besides supplying home requirements, we ought to ship to foreign markets chromic iron, lead, copper, antimony, asphaltum, and ultimately, perhaps, manganese, asbestos, mica, graphite, etc., in much larger quantities than we do or ever have done. And the causes of our being so in fault ought to be inquired into, and, as far as practicable, removed. That a country abounding with the raw material of good quality should be importing iron, fire-bricks, glass, crockery, sulphur, soda and other salts, cement, plaster, marble, and various other commodities of the kind, as we are doing, indicates a lack of economy and thrift that requires prompt correction, since, besides the money sent abroad to purchase these articles being lost to the country, the laborer who should have been employed to produce them is, in a certain sense, deprived of his rights, or at least debarred from opportunities that justly belong to him.

Through the practice of this short-sighted policy there inures a loss to both the State and the individual. It is not always the business that pays the largest dividend to a few owners that is most deserving of encouragement. Some that yield their proprietors very little profit are yet of great public importance, because of the much labor they employ and the sustenance they afford other home industries. The iron company operating at Clipper Gap is of more consequence to the commonwealth than any gold mine in the State, for the reason that it employs more men, thereby giving wide distribution to its earnings, while it keeps large sums of money in the State that would otherwise be sent to other countries to buy iron.

No country possesses the useful metals and minerals in greater variety and abundance than California, and there has been manifested great remissness in that we have so long neglected to render these gifts more conducive to the general welfare.

Inquiry into the wants and conditions of labor accords with the spirit of the age.

The tendencies of our time are towards exact information bearing on the interests of the working classes, the resources of the State, and like economic questions. Hence the Bureau of Labor Statistics, the Mining Bureau, the Manufacturers Association, and various other organizations and movements of recent date, all directed to the fostering of our home industries, and the building up of a system of more diversified pursuits.

The museum connected with the Mining Bureau has come to be much frequented by all classes of people, more especially by strangers, scientists, and miners, visiting the city.

The latter repair to it for the purpose of examining the mineral specimens, and so educating the eye that they will be able to recognize them should similar kind be afterwards met with. Miners can, in some instances, even obtain from the bureau duplicate samples of ores and minerals, which being taken along and used for comparison, better enable them to determine the character of anything encountered when out prospecting; and thus the museum is becoming a training school for miners and students in mineralogy, as well as a place of instruction and amusement for the general public.

INQUIRY INTO ALL OUR ECONOMIC INDUSTRIES.

For several months past Professor Hanks, with such assistance as he could command, has been engaged making a careful examination of every considerable industry in the State, with a view to reporting on the condition and prospects of the same at an early day. While the report will be mainly occupied with a description of the mineral resources of the State, and various other industries, agricultural, commercial, manufacturing, and mechanical, will receive more or less attention, it being the design of the Professor that no important interest shall be wholly overlooked. As this latter class of subjects do not, however, come so wholly within the province of the State Mineralogist's duties, they will be treated of more briefly than mining matters, only the salient points being as a general thing presented.

But while some topics will be necessarily abridged, this report will not consist of old, carelessly compiled, and often used data, but will be fresh, original, and reliable, to which end the Professor and his assistants have gone to primary sources of information for these facts.

They have in no instance accepted the reports of the Census Agent, the Surveyor-General, or the County Assessor as authority, without having first verified the same by further inquiry, the necessity for which has in many cases been made strikingly apparent. With so much care exercised in collecting the information embodied in this paper, it will constitute a very valuable contribution to the economic literature of the day.

In many countries, possessing not a little of the mineral wealth of California, the Government extends every facility to those engaged in mining, going so far often as to offer liberal bounties for the discovery of new mineral deposits, or such as are otherwise of special importance. While our Government, very properly, has left the work of exploration to be effected by individual enterprise, it ought to aid such enterprise at least to the extent above indicated.

If the sum required for maintaining this Mining Bureau in its efficiency and integrity had been large; if the purposes it were intended to subserve had been of a mere speculative kind, not exposed to suffer from postponement; or if so much as a dollar had ever been wasted in the administration of its affairs, there would have been some excuse for such parsimony on the part of the State; but none of these things can be alleged against it; the institution is of the most utilitarian kind—it is an urgent necessity, while its funds, stinted and inefficient almost from the first, have been disbursed with the utmost prudence and frugality.

CHAPTER XIV.

EARNINGS AND EMPLOYMENTS.

From the various sources of information at my command, I have been enabled to compile the following tabulated statements concerning the wage-rates received by the employés in nearly all the branches of manufacturing industries in the State; the average earnings and employment hours of the various employés of the Central Pacific Railroad, and the street railways of San Francisco, Los Angeles, and Santa Rosa; and the number, condition, etc., of persons employed in a large number of selected occupations.

TABLE I.

Employés in Mechanical and Manufacturing Industries (Chinese Excluded).

Occupation.	Wages Paid.				
	Maximum	Minimum	Average	With or Without Board	Per Day, Week, or Month
Asphaltum workers	$2 50	$1 50	$2 00	Without	Day
Awning makers	3 00	2 00	2 50	Without	Day
Employés in agricultural implements	2 50	2 00	2 25	Without	Day
Artificial flowers employés	50 00	30 00	40 00	Without	Month
Bag (cotton) manufacturers	2 50	1 75	2 00	Without	Day
Bag (paper) manufacturers	2 50	1 75	2 00	Without	Day
Bakers	60 00	30 00	45 00	With	Month
Brewers	150 00	60 00		Without	Month
Blacksmiths	4 00	2 00	3 00	Without	Day
Boilermakers	3 00	2 00	2 50	Without	Day
Brass molders	3 00	2 50	2 75	Without	Day
Bookbinders	24 00	15 00	18 50	Without	Week
Brick makers	35 00	30 00	32 50	With	Month
Broom makers	3 00	1 75	2 25	Without	Day
Brush makers	3 20	2 00	2 50	Without	Day
Box (cigar) makers	3 00	2 00	2 50	Without	Day
Box (wood, packing) makers	2 50	2 00	2 25	Without	Day
Cabinet makers	3 00	2 25	2 62½	Without	Day
Candle makers	2 50	2 00	2 25	Without	Day
Canneries (fish, fruit, etc.)—men	2 50	1 50	2 00	Without	Day
Canneries (fish, fruit, etc.)—women	1 00	0 90	0 95	Without	Day
Canneries (fish, fruit, etc.)—boys, girls	0 50	0 50	0 50	Without	Day
Carpenters and joiners	3 50	2 00	2 75	Without	Day
Carpenters (ship)	3 00	2 00	2 50	Without	Day
Carriage and wagon makers	3 00	2 50	2 75	Without	Day
Calkers (ship)	3 50	3 00	2 25	Without	Day
Cement makers	60 00	40 00	50 00	Without	Month
Cigar makers—per thousand	10 00	5 50	7 75	Without	
Cigar makers	3 25	1 50		Without	Day
Confectioners	50 00	30 00	40 00	Without	Month

TABLE I—Continued.

Occupation.	Wages Paid.				
	Maximum	Minimum	Average	With or Without Board	Per Day, Week, or Month
Coffee and spice mills	$50 00	$35 00	$42 50	Without	Month
Coopers	3 00	2 25	2 62½	Without	Day
Coppersmiths	3 00	2 25	2 62½	Without	Day
Cutlers	65 00	45 00	55 00	Without	Month
Employés in distilleries	90 00	45 00	67 50	Without	Month
Employés in dairies	35 00	30 00	32 50	With	Month
Employés in glassworks	2 50	2 00	2 25	Without	Day
Glovemakers—men	3 00	2 00	2 50	Without	Day
Glovemakers—women	1 75	1 25	1 50	Without	Day
Gluemakers	60 00	40 00	50 00	Without	Month
Gunsmiths	3 50	2 00	2 75	Without	Day
Hat and cap makers—men	3 00	1 50		Without	Day
Hat and cap makers—women	1 50	0 90		Without	Day
Iron molders	3 50	2 50	3 00	Without	Day
Ink and mucilage makers	2 75	1 50	2 17½	Without	Day
Locksmiths	2 50	2 00	2 75	Without	Day
Employés in limekilns	35 00	30 00	32 50	With	Month
Machinists	3 50	2 50	3 00	Without	Day
Marblecutters	3 00	2 00	2 50	Without	Day
Employés in watch factories	65 00	45 00	55 00	Without	Month
Employés in match factories	35 00	25 00	37 50	Without	Month
Millers	80 00	45 00	62 50	Without	Month
Pattern makers	4 00	2 25		Without	Day
Employés in paper mills	50 00	35 00		Without	Month
Potters	35 00	30 00	32 50	With	Month
Employés in powder mills	2 50	2 00	2 25	Without	Day
Plumbers	$4 00	$2 50	$3 25	Without	Day
Employés in rolling mills	4 00	3 00	1 75	Without	Day
Ropemakers	2 50	2 00	2 25	Without	Day
Saddlers and harness makers	3 00	2 50	2 25	Without	Day
Sailmakers	4 00			Without	Day
Saltmakers	2 00	1 75	1 87½	Without	Day
Sash, door, and blind makers	3 50	2 50	3 50	Without	Day
Shingle makers	2 50	2 00	2 25	Without	Day
Shoemakers	3 00	2 00	2 50	Without	Day
Soda works employés	35 00			With	Month
Stonecutters	4 00	2 00	3 00	Without	Day
Tailors	3 50	2 50	3 50	Without	Day
Tanners	3 00	2 50	2 75	Without	Day
Tinsmiths	55 00	35 00	45 00	Without	Month
Upholsterers	3 00	1 75	2 37½	Without	Day
Wheelwrights	3 00	2 25	2 62½	Without	Day
Wine manufacturers	2 50	2 00	2 25	Without	Day
Willow and woodware employés	2 50	2 25	2 37½	Without	Day
Woolen mills—men	3 00	2 00	2 50	Without	Day
Woolen mills—women	1 75	1 50	1 62½	Without	Day
Woolen mills—boys	1 00			Without	Day
Woolen mills—girls	0 75			Without	Day

TABLE II.

Relating to Clerical and all other Skilled and Unskilled Labor not before Enumerated (Chinese Excluded).

Occupation.	Wages Paid to Males.				Wages Paid to Females.				Per Day, Week, or Month.
	Maximum.	Minimum.	Average.	With or Without Board.	Maximum.	Minimum.	Average.	With or Without Board.	
Auctioneers*									
Advertising agents*									
Assayers and chemists	$150 00	$75 00		Without					Month
Barbers	21 00	12 00	$16 50	Without					Week
Bookkeepers in all departments	200 00	50 00		Without	$75 00	$35 00		Without	Month
Bricklayers	5 00	4 00	4 50	Without					Day
Bricklayers	75 00	45 00		Without					Month
Butchers	18 00	12 00		Without					Week
Clerks in banking institutions	200 00	60 00		Without					Month
Clerks in insurance offices	200 00	35 00		Without					Month
Clerks in lawyers' offices	100 00	25 00		Without					Month
Clerks in general merchandising	100 00	30 00		Without					Month
Clerks	80 00	40 00		Without					Month
Cooks	150 00	50 00		With					Month
Draughtsmen	10 00	4 00		Without					Day
Draymen	2 50	2 00		Without					Day
Dress and cloak makers					12 00	8 00	10 00	Without	Week
Engravers	5 00	3 00	4 00	Without					Day
Engineers (civil)	150 00	75 00		Without					Month
Engineers (stationary engines)	85 00	60 00		Without					Month
Engineers (mining)	200 00	100 00	150 00	Without					Month
Florists and gardeners	50 00	35 00		Without					Month
Fishermen	40 00	35 00		Without					Month
Gasfitters	21 00	15 00		Without					Week
Glaziers	4 00	3 00	3 50	Without					Day
Hod carriers	3 00	2 00		Without					Day
Horseshoers	21 00	15 00		Without					Week
Hostlers	40 00	30 00	35 00	Without					Month
Laborers	12 00	9 00		Without					Week
Lathers	3 00	2 50		Without					Day
Laundrymen	2 00	1 50	1 75	Without	1 25	1 00		Without	Day

* On commission.

Table II—Continued.

Occupation.	Wages Paid to Males.				Wages Paid to Females.				Per Day, Week, or Month.
	Maximum.	Minimum.	Average.	With or Without Board.	Maximum.	Minimum.	Average.	With or Without Board.	
'Longshoremen (per hour)	$0 40	$0 30		Without					Hour
Lumbermen	45 00	30 00		Without					Month
Masons	4 00	3 00	$3 50	Without					Day
Milliners					$20 00	$8 00	$14 00	Without	Week
Painters (house)	3 50	2 50		Without					Day
Painters (fresco)	6 00	4 00	5 00	Without					Day
Plasterers	5 00	4 00	4 50	Without					Day
Printers	3 75	2 50	3 12½	Without					Day
Salesladies in stores					80 00	40 00	60 00	Without	Month
Seamstresses					25 00	20 00		Without	Month
Servants (domestic)	50 00	30 00	40 00	With	25 00	10 00		Without	Month
Telegraph operators	75 00	30 00		Without	45 00	25 00		Without	Month
Telegraph messenger boys	16 00	12 00		Without					Month
Waiters (restaurant, hotel, etc.)	50 00	35 00		With					Month
Watchmakers	45 00	30 00		Without					Month
Well borers (artesian)†									
Well borers (oil)†									
Wood carvers and turners	4 00	2 50	3 25	Without					Day
Wood cutters§									

† Paid by the foot.
§ Paid by the cord.

TABLE III.

Wages Paid per Day to Employés in Mines (Chinese Excluded).

Occupation.	Maximum.	Minimum.	With or Without Board.
Asphaltum miners	$2 50	$2 00	Without
Coal miners	2 75	2 25	Without
Gold placer miners	3 00	2 50	
Gold quartz miners	3 00	2 50	
Gold hydraulic miners	3 00	2 50	
Silver miners	3 00	2 50	
Gravel miners	3 00	2 50	
Iron miners	3 00	2 50	
Marble miners	2 50	2 00	
Quicksilver miners	4 00	3 00	
Granite stone miners	2 50	2 00	
Limestone miners	2 50	2 00	

TABLE IV.

Wages Paid to Employés of Transportation on Land and Water (Chinese Excluded).

Occupation.	Maximum.	Minimum.	With or Without Board.
Stage drivers	$50 00	$35 00	With
Teamsters hauling, etc.	45 00	30 00	With
Dairymen hauling, etc.	60 00	35 00	Without
Agents, railroad, stage, express, and steamboats*			
Men engaged in express companies	60 00	40 00	Without
Captains of steamboats and sailing vessels	200 00	85 00	With
Pilots	300 00	200 00	With
Pursers	150 00	75 00	With
Engineers	150 00	100 00	With
Freight clerks	100 00	75 00	With
Mates	80 00	40 00	With
Stewards	75 00	50 00	With
Cooks	100 00	30 00	With
Firemen	60 00	40 00	With
Sailors	35 00	25 00	

* Mostly commissions.

TABLE V.

Daily Average Wages of Wage-Workers.

Occupation.	Rate.	Occupation.	Rate.
Brush makers*	$3 00	General tinsmiths	$2 25 to 3 50
Broom makers	2 00 to 3 00	Mechanics' helpers	1 75 to 2 50
Box makers	2 25 to 3 50	Marble rubbers	2 00 to 2 25
Brass workers	2 75 to 5 00	Plasterers' laborers	2 50 to 3 00
Bookbinders	3 00 to 4 00	Teamsters	2 00 to 3 00
Bakers	2 50 to 4 00	Helpers in machine shops	1 75 to 2 25
Brick makers, all classes employed in brickyards	2 00 to 4 00	Chippers	2 00 to 2 50
Block and pump makers	3 00 to 4 00	Brick wheelers in brickyards	2 00 to 2 25
Brewers	2 50 to 3 50	Off-bearers in brickyards, boys	1 25 to 1 50
Bellows makers	3 50 to 4 00	Brickyard workers	2 00 to 2 50
Bricklayers	4 00 to 5 00	Laborers, common day	1 75 to 2 00
Bricklayers, helpers	3 00	Lithographers	3 50 to 5 00
Blacksmiths, all kinds	2 50 to 4 00	Locksmiths	3 00 to 5 00
Coopers	2 50 to 3 50	Porters	1 50 to 2 50
Curriers	3 00 to 5 00	Mathematical instrument makers	3 50 to 6 00
Clerks, in retail stores	2 50 to 6 00	Mechanical draughtsmen	4 50 to 7 00
Corset makers, females	1 25 to 2 00	Millers	2 50 to 5 00
Car builders and repairers	3 00 to 5 00	Millwrights	3 50 to 5 00
Carpet cleaners and renovators	1 75 to 2 50	Marble workers	3 00 to 3 50
Coppersmiths	3 00 to 5 00	Molders	3 00 to 4 50
Street car conductors	1 50 to 2 50	Map mounters	3 00 to 3 50
Carriage makers, painters, trimmers, wood workers, etc.	3 00 to 5 00	Machinists	2 50 to 4 00
Cigar makers	1 25 to 3 00	Pipe makers and setters	2 50 to 3 50
Horse-collar makers	2 50 to 3 50	Pavers and sewer builders	2 00 to 5 00
Cabinet makers	3 00 to 4 00	Planers	2 50 to 3 50
Carpenters	3 00 to 4 00	Plate shearers	2 75 to 3 25
Dyers	2 50 to 3 50	Photographers	2 50 to 3 50
Carvers, ornamental wood	3 00 to 4 00	Paper hangers	2 50 to 4 00
Chair makers	2 50 to 4 00	Pressers	3 00 to 4 00
Car drivers, street cars	2 25 to 2 50	Piano makers†	3 00
Engravers	3 00 to 5 00	Paper rulers	2 00 to 2 50
Engravers, apprentices	1 50 to 2 00	Plumbers	3 00 to 4 00
Engineers	3 00 to 5 00	Plasterers	4 00 to 5 00
File makers	2 50 to 3 50	Printers	3 50 to 4 50
Fresco painters	4 00 to 5 00	Painters	3 00 to 4 00
Finishers	3 50 to 4 00	Glass sign painters	4 00 to 5 00
Fire-brick workers	3 50 to 5 00	Pattern makers	3 00 to 5 00
Flour packers	2 50 to 3 50	Rollers	3 00 to 4 00
Farriers	3 50 to 4 00	Rangers	2 50 to 4 00
Furniture packers	2 50 to 3 00	Roofers	3 00 to 4 00
Firemen	2 50 to 3 00	Steamboat joiners	3 50 to 4 00
Granite cutters	3 50 to 4 00	Shovel makers	2 75 to 3 25
Gas retort makers	3 00 to 4 00	Stair builders	3 50 to 5 00
Glove makers and cutters	2 50 to 4 00	Sewing machine hands	1 75 to 2 50
Galvanized iron workers	3 50 to 5 00	Sheet makers	1 50 to 2 00
Gas and steam pipe fitters	3 00 to 4 00	Ship carpenters	3 50 to 5 00
Grainers	3 50 to 5 00	Sash and blind cutters	2 25 to 3 50
Hammermen	3 00 to 4 00	Sawyers	2 25 to 3 25
Hammermen, helpers and drivers	2 50 to 3 00	Steam fitters	2 50 to 3 50
		Saddle makers	2 50 to 4 00
Hatters	2 50 to 4 00	Stocking makers, females	1 25 to 1 75
Hostlers	1 75 to 2 50	Spring bed makers	2 25 to 3 50
Harness makers	2 50 to 3 50	Stone masons	3 50 to 4 00
Harness makers, apprentices	1 25 to 1 75	Building stone carvers	3 50 to 5 00
Horseshoers	3 50 to 4 00	Shoemakers, in all branches	2 00 to 4 00
Hod carriers	2 50 to 3 00	Shoemakers, boys and girls	75 to 1 50
Instrument makers	3 25 to 5 00	Scale makers	2 50 to 3 50
Joiners	3 00 to 4 00	Safe makers	3 00 to 4 00
Iron workers and railing makers	2 50 to 3 50	Sheet-iron workers	2 50 to 3 50
		Tile molders	3 00 to 3 50
		Tailors	2 50 to 3 50

* Boys, $1 to $1 25; girls, 50 cents to 75 cents.
† Boys, $1 50.

Table V—Continued.

Occupation.	Rate.	Occupation.	Rate.
Trimmers, carriage	$3 00 to 3 50	Wood workers	$3 00 to 4 00
Tanners	2 25 to 3 50	Wagon makers	2 75 to 3 75
Tobacco workers	2 25 to 3 25	Wire cleaners	2 50 to 3 00
Tobacco work'rs, boys and girls	75 to 1 25	Wire drawers	2 25 to 3 50
Tent, awning, and sail makers	2 50 to 4 00	Butchers	2 25 to 3 50
Tent, awning, and sail makers, boys and girls	75 to 1 50	Wire workers	3 00
		Waiters	1 50 to 2 25
Tool makers	3 00 to 4 00	Bartenders	2 50 to 3 50
Tool makers' helpers	1 75 to 2 00	Bookkeepers	3 00 to 6 00
Trunk finishers	2 50 to 4 00	Clerks in wholesale stores	3 00 to 5 00
Tinners	2 50 to 3 00	Calkers	3 00 to 5 00
Tinners, boys	1 00 to 1 25	Rivermen	2 50 to 3 00
Upholsterers	3 00 to 5 00	Salesmen in retail stores	2 50 to 3 50
Varnishers	3 50 to 5 00	Salesmen in wholesale stores	3 50 to 6 00
Whip makers	2 00 to 3 50	Traveling salesmen	3 00 to 4 00
Wood turners	2 50 to 4 00	Miscellaneous workers	2 50 to 5 00
Whiteners	2 50 to 3 00		

TABLE VI.

Average Earnings and Employment Hours of Street Railway Employés in San Francisco, Los Angeles, and Santa Rosa.

Market Street Cable Railway Company, San Francisco.

Employes.	Wages per Day.	Employment Hours.	Wages per Month.	Employment Hours.
Assistant Superintendents and Foremen—				
Four, at			$100 00	13
One, at			75 00	13
One, at			60 00	13
Conductors and collectors—				
Seventy-two, at	$2 50	13		
Eight, at	2 25	13		
Seventeen (boys), at	1 00	13		
Gripmen and motor engineers—				
Sixty-three, at	2 50	13		
Drivers—				
Fourteen, at	2 25	13		
Stables—				
One foreman			85 00	13
One harness maker			90 00	10
One blacksmith			105 00	10
Six blacksmiths			90 00	10
Two blacksmiths			75 00	10
Two blacksmiths			67 50	10
Two blacksmiths			60 00	10
One hostler			60 00	13
Seven hostlers			50 00	13
One harness cleaner			50 00	13
Trackmen—				
One foreman			120 00	10
One paver	3 50	10		
Two laborers	2 50	10		
Six laborers	2 00	10		
Four oilers	2 25	10		
Five oilers	2 00	10		
Three switchmen			75 00	13
Other mechanics—				
Two assistant engineers			100 00	10
Two assistant engineers			90 00	10
One machinist	3 50	10		
One machinist	3 25	10		
One machinist	2 50	10		
Two firemen			70 00	10
Three firemen			65 00	10
One engine wiper	2 00	10		
Three helpers	2 00	10		
One engine cleaner	50	10		
Car house men—				
One grip teacher			75 00	10
One tableman			75 00	13
Six tablemen			60 00	13
One car shifter			60 00	13
One car painter	3 50	10		
One car painter	2 50	10		
Four car cleaners and watchmen			60 00	13
Eight car cleaners			50 00	13
One lamp cleaner and watchman			65 00	13
Two lamp cleaners			60 00	13
Watchmen—				
One special policeman			100 00	13
Three watchmen			60 00	13
Starters and timers—				
Four, at			75 00	13
One, at			42 50	13

Table VI—Continued.

Employes.	Wages per Day.	Employment Hours.	Wages per Month.	Employment Hours.
Carpenters—				
One, at	$3 50	10		
One, at	3 25	10		
One, at	3 00	10		
One, at	2 50	10		
Four, at	2 00	10		
Teamsters—				
One teamster, with horse and car	3 50	10		
One teamster			$50 00	10

Number of hands employed, 388.

Presidio and Ferries Railroad Company, San Francisco.

Employes.	Wages per Week.	Employment Hours (Daily).
Foreman—(1)	$46 70	12
Assistant foreman—(1)	23 35	14
Conductors (men)—(14 "regulars")	14 60	12½
Conductors (boys)—(16 "extras")	10 00	9
Drivers or gripmen—(14 "regulars")	15 50	13
Drivers or gripmen—(14 "extras")	10 00	9
Hostlers—(2)	14 00	14
Blacksmiths—(1)	18 00	10
Track men—(3)	14 70	12
Other mechanics—(8)	15 00	10
Car-house men—(5)	15 75	10
Watchmen—(1)	15 00	13
Starters—(2)	17 50	12½
Boys—(1)	5 75	10

Total number employed, 83 men (*i. e.* 82 men and 1 boy).

North Beach and Mission Railroad Company, San Francisco.

Employes.	Wages per Day.	Employment Hours.
Foreman	$3 00	10
Conductors	2 00	14 to 15
Drivers	2 00	14 to 15
Hostlers	1 66⅔	12
Blacksmiths	2 00 to 3 50	10
Painters	2 00 to 3 25	10
Track men	1 50 to 2 00	10
Other mechanics	2 00 to 3 00	10
Car-house men	1 50	10
Watchmen	2 25	12
Starters	3 00	12
Laborers	1 75 to 2 00	10
Teamsters	2 00	10

Table VI—Continued.

Central Railroad Company, San Francisco.

Employes.	Wages per Day.	Employment Hours (Daily).
Foreman	$2 66	12
Conductors (men)	2 06	14⅓
Drivers	2 03	14
Hostlers	1 66	12
Blacksmiths	3 00	10
Trackmen	2 00	10
Other mechanics	2 75	10
Watchmen	1 66	12
Starters	2 33	12
Laborers	2 00	10
Teamsters	1 75	10

Total number of hands employed, 98.

Potrero and Bay View Railway, San Francisco.

Employes.	Wages per Day.	Employment Hours.	Wages per Month.	Employment Hours.
Foreman—(1)			$60 00	13
Drivers—(6)	$2 25	13		
Hostlers—(3)			50 00	13
Blacksmiths—(1)			90 00	10
Track men, foreman—(1)			75 00	10
Other mechanics, carpenters—(3)	2 00	10		
Watchmen—(1)			50 00	13

Total number of hands employed, 15.

San Francisco City Railroad Company.

Employes.	Wages per Week.	Employment Hours.
Foreman—(1)	$20 00	84
Drivers—(72)	12 25	68
Hostlers—(20)	11 55	84
Blacksmiths	Contract.	
Track men—(5)	13 85	70
Other mechanics—(4)	16 50	60
Car-house men—(2)	12 60	70
Watchmen—(2)	12 15	84
Starters—(1)	16 00	91
Laborers—(1)	14 00	84
Teamsters—(1)	14 00	84

Total number of hands employed, 161.

TABLE VI—Continued.

Clay Street Hill Railway, San Francisco.

Employes.	Wages per Week.	Employment Hours.
Foreman—(1)	$20 00	84
Conductors, men—(6)	17 50	98
Conductors, extra—(5)	8 75	35
Grip men—(6)	17 50	98
Grip men, extra—(4)	8 75	35
Carpenter—(1)	20 00	60
Track men—(1)	16 25	70
Other mechanics—(1)	17 50	60
Car-house men—(1)	15 00	70
Watchmen—(1)	12 50	84
Starters—(1)	15 75	84
Engineer—(1)	25 00	----------
Firemen—(2)	14 00	63
Painter—(1)	18 00	60

Total number of hands employed, 32.

Geary Street Railroad, San Francisco.

Employes.	Wages per Day.	Employment Hours.
Foreman	$2 25	11
Conductors (men)	2 25	13
Drivers (gripmen)	2 25	13
Blacksmiths	2 75	10
Track men	1 75	10
Other mechanics	2 75	10
Car-house men	1 75	10
Watchmen	1 75	12
Starters	2 25	12
Laborers	1 75	10
Teamsters	1 75	10

City Railway of Los Angeles.

Employes.	Wages per Week.
Foreman	$60 75
Drivers—(5)	12 50
Hostlers—(4)	15 00
Track men—(1)	15 00
Laborers—(2)	15 00

Total number of hands employed, 12.

Main Street Railroad Company, Los Angeles.

Employes.	Wages per Month.	Employment Hours.
Foreman—(1)	$100 00	----------
Drivers—(6)	50 00	12
Hostlers—(2)	60 00	12
Track men—(1)	50 00	10

Total number of hands employed, 9.

TABLE VI—Continued.

Santa Rosa Railway, Santa Rosa.

Employes.	Wages (Weekly).	Employment Hours.
Drivers—(1)	$11 50	13

Total number of hands employed, 1.

TABLE VII.

STATEMENT OF NUMBER OF EMPLOYES AND RATES OF PAY OF DIFFERENT CLASSES, PER MONTH, OF THE CENTRAL PACIFIC RAILROAD.

Occupation.	Number.	Rates of Pay.
Agents	225	$50 00 to $225 00
Baggage masters		75 00
Brakemen, flagmen, etc.	740	65 00 to 80 00
Car cleaners	90	60 00
Clerks	4	50 00
Clerks	206	50 00 to 150 00
Clerks	15	60 00
Clerks	4	70 00
Clerks	35	75 00
Clerks	2	80 00
Clerks	9	85 00
Clerks	27	90 00
Clerks	29	90 00 to 200 00
Clerks	2	95 00
Clerks	32	100 00
Clerks	4	105 00
Clerks	6	110 00
Clerks	8	115 00
Clerks	7	120 00
Clerks	18	125 00
Clerks	3	130 00
Clerks	11	135 00
Clerks	10	140 00
Clerks	5	145 00
Clerks	11	150 00
Clerks	2	160 00
Clerks	2	165 00
Clerks	1	170 00
Clerks	4	175 00
Clerks	1	180 00
Clerks	6	200 00
Clerks and draughtsmen	12	75 00 to 200 00
Conductors	221	85 00 to 115 00
Conductors (passenger)		100 00 to 115 00
Conductors (freight)		85 00 to 100 00
Engineers	394	85 00 to 145 00
Engine drivers		100 00 to 130 00
Engine wipers	143	60 00
Employés, other than officers (white)		64 62
Firemen	388	65 00 to 200 00
Foremen	79	105 00 to 200 00
Laborers	1,367	42 00 to 55 00
Laborers	1,437	45 50 to 52 00
Laborers	654	55 00
Laborers, rodmen, etc.	64	35 00 to 90 00
Mechanics	845	52 00 to 84 00
Mechanics	570	60 00 to 85 00
Mechanics, in shops		79 79
Messenger boys	4	20 00 to 35 00

TABLE VII—Continued.

Occupation.	Number.	Rates of Pay.
Patrols	197	$42 00 to $55 00
Porters	18	40 00 to 90 00
Pumpers	60	65 00 to 85 00
Section men (white)	----------	44 62
Shipyard	17	85 00 to 104 00
Station laborers	740	60 00 to 75 00
Steamer crews	287	60 00 to 175 00
Watchmen	50	55 00 to 60 00
Persons regularly employed by company, including officers	11,890	----------
Average monthly pay of employés, other than officers (white)	----------	64 62
Average monthly pay of engine drivers	----------	100 00 to 130 00
Average monthly pay of passenger conductors	----------	100 00 to 115 00
Average monthly pay of freight conductors	----------	85 00 to 100 00
Average monthly pay of baggage masters	----------	75 00
Average monthly pay of brakemen, flagmen, switchmen, etc.	----------	65 00 to 80 00
Average monthly pay of section men (white)	----------	44 62
Average monthly pay of mechanics in shops	----------	79 79
Average monthly pay of laborers at stations, etc.	----------	65 00

TABLE VIII.

PERSONS ENGAGED IN EACH SELECTED OCCUPATION, ETC., IN CALIFORNIA.

Occupation.	All Ages.			Age and Sex.						Nativity.						
	Total	Males	Females	10 to 15.		16 to 59.		60 and over.		United States	Ireland	Germany	Great Britain	Sweden and Norway	British America	Other Countries
				Males	Females	Males	Females	Males	Females							
All occupations	384,437	344,344	28,200	3,423	1,042	327,679	26,592	13,042	566	173,382	35,243	27,345	19,913	4,717	11,314	100,630
Agriculture	79,396	78,785	611	1,128	30	72,762	518	4,895	63	78,662	5,220	4,231	3,465	738	2,291	14,789
Agricultural laborers	23,856	23,722	134	1,038	28	22,189	105	500	1	14,597	1,210	890	648	233	621	5,657
Farmers and planters	43,489	43,091	398			32,263	340	3,828	58	29,133	3,249	2,605	2,304	422	1,352	4,424
Gardeners, nurserymen, and vine-growers	4,396	4,371	25	17	2	4,049	21	305	2	875	316	275	216	21	37	2,656
Stockraisers, drovers, and herders	4,967	4,948	19	65		4,694	17	189	2	2,988	233	220	194	28	59	1,245
Professional and personal services	121,435	103,207	18,228	1,252	793	98,833	17,036	3,122	399	50,993	15,041	6,389	4,300	1,301	2,453	40,898
Barbers and hair dressers	1,918	1,767	151	5	1	1,745	149	17	1	750	38	318	47	5	30	730
Boarding and lodging-house keepers	855	373	482			337	460	36	22	320	167	88	75	12	20	173
Clergymen	939	933	6			835	6	98		586	115	42	70	4	20	102
Clerks and copyists (not specified)	1,223	1,170	53	19		1,140	53	11		1,009	29	37	51	4	18	75
Dentists	413	411	2			396	2	15		335	4	12	21	2	17	22
Domestic servants	22,858	12,160	10,698	304	714	11,689	9,819	167	165	5,896	3,630	1,130	644	280	288	10,990
Hotel and restaurant keepers' employés	6,240	5,672	568	43	1	5,486	553	143	14	2,262	754	861	348	99	148	1,768
Journalists	503	490	13			479	13	11		361	22	28	45		15	32
Laborers	57,510	57,158	352	713	43	54,657	294	1,788	15	23,751	8,016	2,413	1,787	755	1,329	19,459
Launderers and laundresses	7,013	5,996	1,017	41	5	5,913	965	42	47	687	378	103	70	17	24	5,734
Lawyers	1,899	1,897	2			1,780	2	117		1,634	69	36	77	3	34	46
Livery stable keepers and hostlers	1,932	1,932		9		1,889		34		1,134	442	85	90	11	77	93
Musicians and teachers of music	1,497	845	652	3	5	816	640	26	7	859	36	275	90	9	21	207
Officials and employés (civil) of government	3,789	3,624	165	2	1	3,662	161	160	3	2,811	387	159	174	24	83	151
Physicians and surgeons	1,851	1,786	65			1,583	59	203	6	1,188	61	112	98	6	65	321
Teachers	4,788	1,691	3,097	1	2	1,633	64	57	31	3,970	158	124	154	5	132	245
Trade and transportation	57,392	56,621	771	429	27	54,843	714	1,349	30	27,667	6,009	7,473	3,400	1,143	1,498	10,202
Clerks, salesmen, and accountants in stores	11,835	11,553	282	237	19	11,197	262	119	1	7,903	611	1,195	637	62	286	1,141
Commercial travelers, hucksters, and peddlers	2,974	2,931	43	6	2	2,863	36	62	5	613	192	286	104	10	37	1,732
In banking and brokerage of money and stocks	1,431	1,423	8	3		1,366	7	54	1	956	88	154	105	2	29	97
In insurance	568	562	6	3		539	6	20		389	37	58	44	2	5	33
Saloon keepers and bartenders	4,063	4,015	48	6		3,899	47	110	1	1,524	576	1,023	228	60	126	526
Traders and dealers	14,920	14,656	264			14,145	249	511	15	5,881	1,272	3,092	824	83	306	3,462
Draymen, hackmen, teamsters, etc.	6,007	6,007		19		5,854		134		3,715	893	383	287	51	267	411
Officials and employés of express companies	647	646	1	3		631	1	12		340	140	61	40	12	20	34
Officials and employés of railroad companies	11,890															
Officials and employés of street railroad companies	615	615				607		8	1	304	211	27	28	5	22	18

Officials and employés of telegraph companies	577	550	27	67	------	482	27	1	------	501	11	5	16	1	32	11
Sailors, steamboatmen, stewardesses, canalmen, pilots, and watermen	5,523	5,523	--------	9	------	5,436	--------	78	------	1,553	655	705	601	763	137	1,109
Manufacturing, mechanical, and mining industries	118,282	109,690	8,592	621	193	105,363	8,324	3,706	------	48,084	9,669	9,337	8,869	1,561	5,199	35,563
Apprentices to trades	1,107	875	142	121	35	754	107	--------	------	906	19	16	24	6	14	32
Bakers	1,368	1,275	93	3	------	1,227	90	45	3	290	145	553	85	20	30	245
Blacksmiths	4,689	4,689	--------	11	------	4,538	--------	140	------	2,631	593	349	407	56	381	272
Bookbinders and finishers	225	162	63	9	6	149	57	4	------	162	17	23	7	1	4	11
Boot and shoemakers	4,577	4,411	166	21	5	4,225	160	165	1	894	587	540	195	41	127	2,193
Brewers and malsters	749	741	1	3	------	734	1	11	------	124	50	459	27	2	16	71
Brick and stonemasons, marble and stonecutters	1,565	1,565	--------	6	------	1,465	--------	94	------	732	368	103	186	12	39	125
Brick and tile makers	709	708	1	------	------	70	1	7	------	83	51	25	10	14	188	338
Butchers	3,301	3,301	--------	20	------	3,224	--------	57	------	1,612	207	774	158	22	67	461
Cabinetmakers and upholsterers	1,378	1,307	8	5	------	1,307	8	58	------	573	73	410	70	43	43	166
Carpenters and joiners	9,056	9,056	--------	11	------	8,520	--------	525	------	5,448	728	644	765	149	654	628
Carriage, car, and wagonmakers	844	844	--------	3	------	809	--------	32	------	464	68	88	54	21	109	40
Cigar makers and tobacco workers	3,217	3,163	54	49	9	3,104	45	10	------	255	11	157	26	3	8	2,757
Clerks and bookkeepers in manufac'g establishm'ts	281	277	4	1	------	274	4	2	------	227	7	14	13	2	6	12
Coopers	553	553	--------	4	------	523	--------	26	------	224	87	128	18	17	17	62
Cotton, woolen, and silk-mill operatives	776	622	154	25	7	590	144	7	3	343	96	19	67	4	12	235
Employés in manufac'g establishm'ts (not specified)	627	570	57	11	2	552	55	7	------	315	49	56	32	9	21	145
Engineers and firemen	2,874	2,874	--------	------	------	2,814	--------	60	------	1,763	351	138	373	34	81	134
Fishermen and oystermen	3,010	3,008	2	6	------	2,974	2	28	------	246	60	58	33	37	998	1,578
Gold and silver workers and jewelers	550	548	2	1	------	536	2	11	------	254	9	108	40	11	5	123
Harness, saddle, and trunk makers	1,138	1,109	29	11	------	1,066	29	32	------	684	106	119	63	7	50	109
Iron and steel workers	1,099	1,099	--------	5	------	1,082	--------	12	------	535	235	54	155	24	30	66
Leather curriers, dressers, finishers, and tanners	712	712	--------	7	------	697	--------	8	------	200	142	148	30	8	37	147
Lumbermen, raftsmen, and woodchoppers	4,433	4,433	--------	6	------	4,347	--------	80	------	1,795	215	108	174	180	555	1,406
Machinists	1,824	1,824	--------	5	------	1,764	--------	55	------	1,118	121	153	238	26	63	105
Manufacturers and officials of manufac'g companies	1,203	1,192	11	------	------	1,148	11	44	------	658	55	185	81	1	36	187
Mill and factory operatives (not specified)	675	588	87	21	8	565	77	2	2	38	48	33	21	15	27	151
Millers	547	547	--------	3	------	510	--------	34	------	349	21	61	47	12	29	28
Miners	37,147	37,141	6	73	------	35,388	6	1,680	------	9,281	2,513	1,431	3,770	369	692	19,091
Painters and varnishers	3,323	3,314	9	8	1	3,239	7	67	1	2,048	321	271	293	53	100	237
Paper-mill operatives	160	153	7	5	------	146	7	2	------	66	8	3	8	1	7	67
Plumbers and gasfitters	841	841	--------	9	------	830	--------	2	------	566	115	29	76	1	25	29
Printers	2,232	2,130	102	33	2	2,079	100	18	------	1,820	84	62	100	6	45	115
Sawmill operatives	1,281	1,281	--------	16	------	1,253	--------	12	------	644	57	42	63	48	101	326
Ship carpenters, calkers, riggers, and smiths	719	719	--------	------	------	691	--------	28	------	354	111	39	93	20	59	43
Tailors, dressmakers, and milliners	9,516	2,544	6,972	10	100	2,421	6,821	113	51	5,094	886	898	404	136	218	1,880
Tinners	1,141	1,132	9	10	------	1,098	9	24	------	723	60	126	70	13	28	121
Wheelwrights	317	317	--------	1	------	302	--------	14	------	208	21	23	16	7	23	19

CHAPTER XV.

LABOR SAVING MACHINERY.

Of the extent of the vast increase in the producing power of machinery in all branches of industry, it is almost impossible to determine, either by comparison or statistics. It is to be regretted that full details cannot be obtained at this writing of the effect of machinery on the productions of the country. There are but few occupations in this country in which machinery is not employed. The displacement of hand labor by machinery is felt in all the great industries of the country. Machinery in California causes increased production in all or nearly all of the industries of the State. The work done by machinery in this State in the year 1884 equals at least ten times the work of hand labor.

As early as the year 1845 manufacturing was carried on by the aid of machinery in Massachusetts. As an evidence of the increased power of production through machinery, the following table is taken from the Massachusetts census of 1875:

Manufactures.	1845.	1855.	1865.	1875.
Boots and shoes:				
Number of establishments	------------	------------	206	1,461
Capital invested	------------	------------	$10,322,599	$18,692,864
Value of stock used	------------	------------	36,418,845	54,976,504
Persons employed	45,877	77,827	52,821	48,090
Value of goods made	$14,799,140	$37,501,725	$56,113,987	$89,375,792
Pairs of boots and shoes made	20,896,312	45,066,828	31,870,581	59,762,866
Cotton goods:				
Number of establishments	302	294	237	220
Number of spindles	817,483	1,519,527	1,913,756	3,859,237
Capital invested	$17,739,000	$31,961,000	$33,822,086	$63,844,708
Value of stock used	------------	------------	50,393,831	41,059,893
Persons employed	20,710	34,787	24,151	60,176
Value of goods made	$12,193,449	$26,140,537	$55,508,447	$77,934,753
Yards of cloth made	178,401,614	318,224,188	175,875,934	874,780,874
Woolen goods:				
Number of establishments	178	146	231	183
Number of sets machinery	514	695	1,157	1,383
Capital invested	$5,604,002	$7,305,500	$14,714,672	$17,209,980
Value of stock used	------------	------------	35,377,996	23,607,561
Persons employed	7,372	10,090	18,753	19,036
Value of goods made	$8,377,478	$12,105,512	$48,879,828	$39,566,378
Yards of cloth made	23,877,819	26,168,130	46,008,141	90,208,280

By reference to the foregoing tables, these facts are the most salient: In 1845, it will be seen by a simple sum in division, that the annual average production in boots and shoes for employés was 455 pairs; while in 1875, it was 1,242 pairs, showing the wonderful producing power of machinery, for, while in 1875, the number of men employed was less than 3,000 more than those employed in 1845, yet the production was three times as much.

In the manufacture of cotton goods, the first noticeable thing in the table is the steady decrease in the number of establishments. In 1845, the number of employés to each establishment averaged 68 persons. Ten years later, 118 persons; and in 1875, 273 persons. The average number of yards of cloth per employés made in 1845, was 8,614, in 1875, was 14,537 yards.

In the manufacture of woolen goods, the increased production per employé, was as follows: In 1845, the number of yards of cloth made per employé, was 1,882, and in 1875, was 4,738 yards.

THE GENERAL APPLICATION OF THE FACTORY SYSTEM.

In nearly all industries where the terms of the definition of a factory can apply, that is, where raw material can be converted into finished goods by consecutive harmonious processes, carried along by a central power, the factory system has been adopted. In all textile manufactures this has been the case, and the adoption of the new system in the woolen, silk, worsted, flax, and all textile trades, followed immediately upon, or was contemporaneous with, the adoption of the system in the cotton trade. Outside of the textile trades the extension of the system has been rapid indeed, until the statistics of industries of Great Britain and of the United States are simply the statistics of manufactures under the factory system. This statement is, in the main, true of Belgium, France, and Germany, although in France a very large proportion of weaving, especially of fine goods and silks, is still done by hand. In the silk industry in France, however, the power-loom is now rapidly displacing the hand-loom. Notwithstanding this general adoption of the system by the textile trades in the great manufacturing states of Europe and America, more than one half the population of the globe is clothed with hand-made goods.

While the inauguration of the factory system in the United States was some fifteen years later than its birth in England, the extension of the system has been more rapid and its applications more varied here than in any other country. As parties engaged in industries other than the manufacture of textiles saw the wonderful results of systemized labor, by its division under the scientific methods of the factory system, they gradually adopted the new order, until now it is quite safe to say that of the nearly three millions of people employed in the mechanical industries of this country at least four fifths are working under the factory system. Some of the other remarkable instances of the application of the system are to be found in the manufacture of boots and shoes, of watches, musical instruments, clothing, agricultural implements, metallic goods generally, firearms, carriages and wagons, wooden goods, rubber goods, and even in the slaughtering of hogs. Most of these industries have been brought under the factory system during the past thirty years.

It is but a comparatively few years since the manufacture of boots and shoes was carried on in the little home shops which were attached to or built near the dwelling of the shoemakers. These little shops in which a few men, rarely more than four, worked, upon the bench, upon stock received from the manufacturer, cut out and ready to be put together, are closed, and the great shoe factory takes their place.

In the shoe factory is to be seen the perfect adaptation of the manufacture of goods by successive, harmonious processes. The shoe factory is rapidly doing away with the clogs of England and the sabots of the continent. The watch factory presents, perhaps, the most complete scientific application of the factory system. It certainly has brought the watch within the means of the poor man. Pianos, house organs, tapestry, carpets, and many other luxuries which the rich only could afford, are now enjoyed by the masses, simply as the result of the factory system of industry.

The history of the achievements of the modern system would require volumes devoted to that particular subject. The instances referred to indicate the vast extent of the application of the system. If they do not, the fact that the product of the industries of the United States has reached $7,000,000,000 per annum will illustrate the extent of its growth.

Many goods are made under a mixed system of manufacture, but the tendency is to bring all under the factory system as rapidly as possible. This tendency is accelerated by the small expense and the comparative ease with which inventions are secured and protected in this country; and this may account, in some degree, for the more general adoption of the system here than in other countries. It is quite impossible to arrive at an accurate statement as to the number of persons it would require under the old individual system to produce the goods made by the present factory workers of this country, but by careful computations in some branches of work a rough estimate of the whole would indicate that each factory system employé in 1883 represents, on an average, at least fifty employés under the individual system. Thus it would require about one hundred and fifty million persons working under the old system to produce the goods made by the three million or so factory workers of to-day. This computation may be very wide of the truth, but any other is equally startling. This estimate will hardly be disputed when it is considered that in spinning alone eleven hundred threads are spun now at one time, where one was spun under the old system.—[*Census Report.*

CHAPTER XVI.

RECOMMENDATIONS.

One of the greatest changes in the principles of law, which the factory system has wrought, is in relation to the liability of employers for injuries received by their workmen. The question as to how far employers shall be held liable for damages to their employés, for accidents occurring through the negligence of co-employés, is creating a good deal of discussion in England, and has, in a limited degree, already commanded attention in this country.

The employer is now liable for two classes of injuries caused by fellow-workmen: when he has directly interfered in the act which caused the injury, and when, by his negligence in selecting, he has employed an incompetent workman. In all other cases, except where special legislative restriction exists, he is not liable for injuries to co-workmen, unless by special contract he assumes to become liable; but the employer never, or rarely, suggests such contract; this must come from the workman.

The necessity exists for legislative action, making the employer also liable for all injuries caused by his authorized agents in the legitimate performance of the duties which he has prescribed, such regulation to apply to industrial works and railroads.

Legislatures in America and elsewhere have felt the influence brought to bear in favor of some law upon the subject. In the year 1880, in England, a law was passed, known as the Employers' Liability Act, which provides a remedy and compensation for personal injury caused to workmen. In the State of Iowa the law provides that "Every railroad company shall be liable for all damages sustained by any person, including employés of the company, in consequence of any neglect of its agents, or by any mismanagement of its engineers or employés of the company."

The following agreement was furnished this office by an aged and infirm parent whose sons were in the employ of the firm named in this agreement. The sons were requested to sign this agreement, as a condition to their employment, and the father to sign the same, thereby acknowledging himself bound by all the terms thereof:

For and in consideration of my employment by the firm of —— —— in and about their business at Nos. 215, 217, and 219 Bush Street, San Francisco, I do, for myself, my heirs, executors, and administrators, hereby release, forgive, and waive any and all claims against said firm for damages or injuries sustained or suffered by me, or which I may sustain or suffer while in said employment, by reason of the acts of my employers or either of them, or of any of my co-employés in and about said business, or resulting from the use of any of the presses, elevators, machinery, or appliances used in and about said business, or which may be put, or used, in or about the same during my employment by said firm, regardless of the question whether such damage or injury result from carelessness or otherwise.

Dated San Francisco. ———, 188—.

—— ——.

Witness: ——— ———.

In consideration of the employment by the firm of —— —— of my ———, who has signed the agreement on the other side of this paper, —— being a minor, I, ——— ——— of said minor, do hereby consent to and ratify said employment and agreement, and hereby acknowledge myself bound by all the terms and conditions thereof.

——— ———

Dated San Francisco, ———, 188—.

Witness, ——— ———.

Whether a firm or individual employer has any legal right to enforce such an agreement is a question into which I do not propose at present to enter. I cannot, however, refrain from entering a strong objection to the use of any such conditional document, and in order to bring the issue squarely before your honorable body, I have prepared the following draft of an Act, which I commend to your attention:

Be it enacted:

That when personal injury is caused to a workman by reason of any defect in the ways, works, machinery, or plant connected or used in the business of the employer; or by reason of the negligence of any person in the service of the employer who has any superintendence intrusted to him, while in the exercise of such superintendence; or by reason of the negligence of any person in the service of the employer to whose orders or directions the workman at the time of the injury was bound to conform, and did conform, when such injury resulted from his having so conformed; or by reason of the act or omission of any person in the service of the employer done or made in obedience to the rules or by-laws of the employer, or in obedience to particular instructions given by any person delegated with the authority of the employer in that behalf; or by reason of the negligence of any person in the service of the employer, or who has charge or control of any signal points, locomotive engine, or train upon a railway; in all these cases the workman shall have the same right of compensation and remedies against the employer as if he had not been a workman of or in the service of the employer.

MECHANICS' LIEN.

I have further to call your attention to the following draft of an Act on the important subject of the mechanics' lien, which I also recommend:

Section 1. That every person who shall have performed any labor in the service of any person or corporation, who shall hereafter assign property in trust for the benefit of creditors, shall be entitled to receive, out of the trust fund when the same is insufficient to pay all debts of the assignor, the full amount of the wages due to such person for such labor; *provided,* that such labor shall have been performed within twelve months immediately preceding the assignment.

Sec. 2. This Act shall take effect from and after its passage.

COÖPERATIVE UNIONS.

Lastly, I have prepared the following draft of an Act, referring to coöperative trades unions, which I also present, with a recommendation that it be passed:

Section 1. That any number of persons, not less than five, may associate themselves together for the purpose of mutual protection and relief of its members, and for the payment of stipulated sums of money to the families or heirs of the deceased members of such association.

Sec. 2. That the trustees and officers thereof shall be chosen in such manner and for such time as may be provided in the rules and regulations of such association; and when chosen, said trustees shall, under their hands and seals, make a certificate, which shall specify as follows:

First—The name of such association, and by which it shall be known.

Second—The name of the place where its principal office is or shall be located.

Third—The manner of carrying on the business of said association.

Sec. 3. That when organized, as provided in Section 2, the persons named as corporators in said certificate are hereby authorized to carry into effect the objects named in said certificate, in accordance with the provisions of this Act; and their associates and assigns, by the name provided in said certificate, shall thereafter be deemed a body corporate, with succession, and shall have power to receive money either by voluntary donation or contribution, or to collect the same by assessment on its members, and to distribute, invest, and appropriate the same in such manner as such association may deem proper, with power to sue and be sued, plead and be impleaded, defend and be defended, contract and be contracted with, acquire and convey at pleasure all such real and personal estate as may be necessary and convenient to carry into effect the objects of the association; to make and to use a common seal, and the same to alter at pleasure; and do all needful acts to carry into effect the objects for which it was created, in such manner and for such purpose as may be prescribed by the rules and regulations of the association, not inconsistent with the laws of the State and the purposes of the association as above expressed.

SEC. 4. This Act to take effect from and after its passage.

ACKNOWLEDGMENTS.

The Bureau of Labor Statistics takes this method of expressing its special obligations to its ex-deputy, H. J. Mohan, and to Jesse Å. Galland, deputy in this office; to Thos. J. Vivian, for valuable and intelligent assistance; to S. S. Bamberger, for aid in the preparation of circulars; and to the various labor organizations, for their suggestions, advice, and encouragement.

FINANCIAL STATEMENT.

By the law creating this bureau, approved March 3, 1883, the following appropriations were made for the first two years:

For office rent	$50 per month
Office furniture	$500
Salary of Commissioner	$2,400 per annum
Salary of Deputy Commissioner	1,500 per annum
Stationery and other contingent expenses	500 per annum

STATEMENT OF EXPENDITURES FROM MARCH, 1883, TO JANUARY 1, 1885.

Salary of Commissioner from Opening of Bureau, 1883, to Close of 1884.

1883.		1884.	
March	$160 00	February 29	$200 00
April 30	200 00	March 31	200 00
May 31	200 00	April 30	200 00
June 30	200 00	May 31	200 00
July 31	200 00	June 30	200 00
August 31	200 00	July 31	200 00
September 29	200 00	August 31	200 00
October 31	200 00	September 30	200 00
November 30	200 00	October 31	200 00
December 31	200 00	November 30	200 00
1884.		December 31	200 00
January 31	200 00	Twenty-one months	$4,360 00

Salary of Deputy Commissioner from Opening of Bureau, 1883, to Close of 1884.

1883.		1884.	
March —	$95 80	February 29	$125 00
April 30	125 00	March 31	125 00
May 31	125 00	April 30	125 00
June 30	125 00	May 31	125 00
July 31	125 00	June 30	125 00
August 31	125 00	July 31	125 00
September 29	125 00	August 30	125 00
October 31	125 00	September 30	125 00
November 30	125 00	October 31	125 00
December 31	125 00	November 30	125 00
1884.		December 31	125 00
January 31	125 00	Total	$2,720 80

Statement of Office Furniture Account.

Appropriation		$500 00
June 1, 1883	$422 80	
January 19, 1884	77 00	
		499 80
Balance		$0 20

(Vouchers for the above on file.)

Financial Statement—Continued.

Office Rent Statement.

1883.		1884.	
April	$50 00	March	$50 00
May	50 00	April	50 00
June	50 00	May	50 00
July	50 00	June	50 00
August	50 00	July	50 00
September	50 00	August	50 00
October	50 00	September	50 00
November	50 00	October	50 00
December	50 00	November	50 00
1884.		December	50 00
January	50 00	Twenty-one months	$1,050 00
February	50 00		

(Vouchers for the above on file.)

Stationery and Contingent Expenses.

1883.		1884.	
June 1	$17 95	February 6	$21 05
August 6	156 40	March 24	58 35
August 6	45 60	May 21	106 55
September 7	73 85	May 27	50 00
October 18	48 75	July 21	55 50
November 16	60 00	October 19	179 48
December 7	76 40		
		Total	$949 88

(Vouchers for the above on file.)

APPENDIX.

CHAPTER I.

THE MANUFACTURING INDUSTRY.

RELATION OF WAGES AND MATERIALS TO PRODUCTS.

It is evident, that in any comparison of State with State or of city with city, as regards their respective manufacturing importance, or of industry with industry, as regards their respective contributions to the wealth of the country, the value of the materials consumed should be deducted from the reported aggregate value of the products before such comparisons are made.

The neglect of this simple and natural rule has led to grave misunderstanding of the proper effect of the census statistics of manufactures, and to many bitter complaints on the part of cities and of States deeming themselves injured.*

It is also evident, that in estimating the contributions made by the manufacturing industries, as a whole, to the annual revenue of the country, a similar deduction should be made. Thus, while the aggregate value of the manufactures of the United States is reported in 1880 at $5,369,571,191, and in 1884 at $7,500,000,000, the value of the materials consumed therein is given at not less than $3,396,823,549.

It is the difference between these two sums—$1,972,755,642—which measures the net product of our manufacturing industries. This deduction would require to be made were all the materials of manufacture drawn, in every case, directly from agriculture; but, as a matter of fact, the products of one industry often become the materials of another, and the products of this, perhaps, in turn the materials of a third industry; and so the values of manufactured products are swollen by the repeated inclusion of the same original subject-matter. Thus, certain amounts of coal, iron ore, limestone, and labor—not to speak of other elements—enter to make up the value of a certain quantity of pig iron. All the latter may, a few months later, become the material for the manufacture of a certain quantity of bar-iron, the reported value of which, of course, includes the value of the pig-iron, as well as of the labor and other elements in its own production. In this way the value of the coal, iron ore, and limestone, reappear again and again, through successive processes of manufacture.

And this is statistically right. Only in this way can the facts of each industry by turns be exhibited. To omit these elements at any stage of production would be to misstate the facts of the particular

* See letter of the late Superintendent of Census, with reference to the manufacturing statistics of Philadelphia.

industry concerned. But it is evident that this statistical condition renders it imperative not to consider the aggregated values of all products of manufacture as an addition to the wealth of the country; but, on the contrary, in all comparisons of the nature referred to the value of materials should uniformly be deducted.

The relation of materials to product, in the statistics of industry, needs to be carefully borne in mind; otherwise the most mistaken views of the importance of the several branches of industry will result.

The manufacturing and mechanical industries may be grouped in respect of the value of materials into four classes:

First—Those industries in which the subject-matter is of a distinct and immediate commercial value, but the property does not reside in the person who treats it. In these cases, still, the value of the subject-matter treated is not embraced in the return of materials. A familiar illustration is that of horseshoeing. It would be height of absurdity for the smith, for example, to return the value of unshod horses among his "materials," and the value of the same, when shod, in his product. The census assigns as the materials of his industry merely the coal, iron, steel, etc., used, and, as the value of his product, merely the price of the personal service he renders, plus the cost of those materials In the same category are many of the trades. The returns in respect to the industries of painting, plastering, and plumbing, for example, do not take into account the value of the houses, stores, factories, etc., before and after these operations, but regard only the added value given as the product, and in the same way only the paints, the plaster and lime, the tubing, iron and brassware, etc., used as the "materials" of these industries.

Second—Those industries in which the entire value of the subject-matter is carried into the value of "materials," and appears again in the product, enhanced by the value of labor, by the charges for the use of capital, for rent, freight, etc., but in which the value of such subject-matter is small compared to the cost of labor. The cabinet-maker takes a few dollars' worth of woods, coarse or fine, and works up this material into articles bearing ten times the value. The cutler takes a few pounds of steel, and produces edged or pointed instruments of high cost, because of the time and skill required in their fabrication. In all these cases the value of the product is not greatly enhanced by the fact that the entire subject-matter of the industry is included.

Third—Industries which are otherwise under the same conditions as those of the second class, but in which the value of the materials approaches, or even moderately exceeds, the value of the labor employed, and becomes thus an important element in the final value of the product as reported, enhancing the apparent production of the industry in a high degree. Here comes in the great body of the industries known technically as the "manufacturers" of the country, the mill and factory industries, whose productions appear oftentimes enormous as compared with those of bodies of craftsmen more skilled and receiving higher wages, and do so merely because of the high cost of the materials consumed in the former case.

Fourth—Industries in which the value of the materials far exceeds all the other elements in the cost of production combined, and thus carries up the apparent product of these industries to a very high point, although, in fact, comparatively little value has been added by these operations, and only a small number of artisans or laborers supported.

The reduction of gold and silver, calico printing, bleaching and dyeing, the currying of leather, the packing of meat, the refining of sugar and molasses, and the production of flour and meal, are among the most important industries of this class.

The distribution of the industries embraced in Table I, as nearly as possible, according to the classification just indicated, yields the following instructive results:

TABLE I.

Relation of Wages and Materials to Products in Manufacturing and Mechanical Industries.

1880–1883.

Class.	Number of Hands Employed.	Amount Paid in Wages.	Value of Materials.	Value of Products.
I	123,787	$46,972,802	$64,875,494	$164,523,518
II	240,365	91,618,876	86,007,672	252,180,128
III	2,254,204	768,628,877	2,227,225,636	3,796,006,063
IV	114,239	40,733,240	1,018,714,747	1,156,869,482
Totals	2,732,595	$947,953,795	$3,396,823,549	$5,369,579,191
1883—Totals	2,975,000	$1,147,000,000		$7,500,000,000

Class.	Excess of Products over Materials.	Excess of Products over Wages and Materials.	Wages in $100 of Products.	Materials in $100 of Products.	Wages and Materials in $100 of Products.	Product per Capita, gross.	Product per Capita, gross, Deducting Materials.
I	$99,648,024	$52,675,222	$28 55	$39 43	$67 98	$1,329 08	$804 99
II	166,172,456	74,553,580	36 33	34 10	70 43	1,049 15	691 33
III	1,568,780,427	800,151,550	20 25	58 67	78 92	1,683 96	695 93
IV	138,154,735	97,421,495	3 52	88 05	91 57	10,126 74	1,209 34
Totals	$1,972,755,642	$1,024,801,847	$17 65	$63 26	$80 91	$1,965 01	$721 93

TABLE I—Continued.

1870.

Class.	Number of Hands Employed.	Amount Paid in Wages.	Value of Materials.	Value of Products.
I	110,504	$35,689,883	$67,850,482	$154,692,177
II	380,112	160,543,329	172,617,561	503,281,690
III	1,420,345	535,293,694	1,483,951,729	2,636,790,545
IV	98,778	30,769,841	692,676,576	822,792,139
Totals	2,009,739	$762,296,747	$2,417,096,348	$4,117,556,551

Class.	Excess of Products over Materials.	Excess of Products over Wages and Materials.	Wages in $100 of Products.	Materials in $100 of Products.	Wages and Materials in $100 of Products.	Product per Capita, gross.	Product per Capita, gross, Deducting Materials.
I	$86,841,695	$51,151,812	$23 07	$43 86	$66 93	$1,400 00	$785 87
II	330,664,129	170,120,800	31 89	34 30	66 19	1,324 03	869 91
III	1,152,838,816	617,545,122	20 30	56 28	76 58	1,856 44	811 66
IV	130,115,563	99,345,722	3 74	84 18	87 92	8,329 71	1,317 25
Totals	$1,700,460,203	$938,163,456	$18 51	$58 70	$77 21	$2,048 80	$846 11

The calculations which have been added to show the number of dollars' worth of wages, and of materials, separately and combined, in each hundred dollars of product, and also the average value of production, gross and net, to each hand employed, are well worth studying.

It appears that the value of the materials consumed in the several groups of industries range from $34 10 to $88 05 in each $100 of product; that the amount of wages ranges (going so to speak, in the opposite direction) from $36 33 to $3 52 in each $100 of product, while the gross product per capita ranges from $1,049 15 to $10,126 74, and the net product ranges from $691 33 to $1,209 34. The reasons for these astonishing differences is not found chiefly in any difference in the quality of labor, or in the more extensive application of machinery in one class than in another, but almost wholly in the treatment of this subject of the materials consumed in the successive industries, and classes of industries.

THE PERIOD COVERED BY THE RETURNS.

It needs to be borne carefully in mind, in the use of the above tables, that the period covered by the returns is the twelve months from June 1, 1879, to May 31, 1880, inclusive. The fluctuations of productive industry are so incessant, and so extensive, that it is necessary to fix precisely the period covered by any statement before tests can be supplied to ascertain its completeness and accuracy. Especially in the United States, where these fluctuations are far greater than in older manufacturing countries, it is essential to observe this caution.

It often happens that the comparison of two twelve months periods, having so many as ten or eleven months in common, will exhibit important differences caused by the eleventh or twelfth month, or both.

This caution is of especial importance in connection with the tenth census, inasmuch as the first portion of the census year was embraced within the long period of industrial inactivity which had succeeded the panic of 1873, while the latter months of the year witnessed an almost fierce resumption of manufacturing industry.

INCREASE OF MANUFACTURING INDUSTRY, 1850-1883.

The growth of the United States in manufacturing is one of the most noteworthy features of the present industrial age. It is not easy to say which is the best test of that growth; but the application of any one of the several tests offered by the tables common * to the last four censuses, shows our national progress in this direction to have been remarkable.

Years.	Gross Value of Products.	Gain per Cent in 10 Years.	Gain per Cent in 20 Years.	Gain per Cent in 33 Years.
1850	†$1,019,109,616			
1860	1,885,861,676	85.05		
1870	4,232,325,442	124.42	315.30	
1883	8,500,000,000			

* With certain exceptions which are not of sufficient importance to require to be noted for the purposes of the following discussion.

† This is the true total. The total published is $1,019,106,616.

It is noted in another place, that in comparisons of 1870 with 1880, on the one hand, or with 1860 on the other, it should be borne in mind that the figures for 1870 are stated in a currency which was at a great discount in gold, the average premium on gold being for the twelve months, June 1, 1869, to May 31, 1870, 25.3 per cent, which is closely equivalent to a discount on currency of 20 per cent. If, then, we discount the reported values of 1870 by one fifth, we shall have as our corrected table, the following:

YEAR.	Corrected Gross Value of Manufactured Products.	Corrected Gain per Cent in 10 Years.	Corrected Gain per Cent in 20 Years.	Corrected Gain per Cent in 33 Years.
1850	$1,019,109,616			
1860	1,885,861,676	85.05		
1870	3,385,860,354	79.54	232.24	
1883	8,500,000,000			

Again, we may inquire what has been the increase in the net value of manufactured products reported in the four successive censuses taken for the purposes of this comparison; that is, the value of the products after deduction of the value of the materials consumed:

YEAR.	Net Value of Products Manufactured.	Gain per Cent in 10 Years.	Gain per Cent in 20 Years.	Gain per Cent in 33 Years.
1850	*$463,935,296			
1860	854,256,584	84.13		
1870	1,743,898,200	104.14	275.89	
1883	2,220,000			

*The true total of materials is $555,174,320. The one published is $555,123,822.

Discounting the figures for 1870 on account of the premiums on gold, as we did with the figures reporting gross product, we should have the corrected table of the net values of manufactured products, as follows:

YEAR.	Corrected Net Value of Manufactured Products.	Corrected Gain per Cent in 10 Years.	Corrected Gain per Cent in 20 Years.	Corrected Gain per Cent in 33 Years.
1850	$463,935,296			
1860	854,256,584	84.13		
1870	1,395,118,560	63.31	200.71	
1883	2,220,000			

Again, we may take the figures of capital reported as invested in manufacturing industries at the successive periods under consideration, as affording a certain measure of the growth of the country in industrial power, although there is too much reason to believe that the returns of capital have always been gravely defective, for reasons which will be adverted to hereafter. Assuming, however, that the liability to omission or defective statement remained of constant force from 1850 to 1880, we should have the following progressive results:

YEAR.	Capital Invested in Manufactures.	Gain per Cent in 10 Years.	Gain per Cent in 20 Years.	Gain per Cent in 33 Years.
1850	$533,245,351			
1860	1,009,855,715	89.38		
1870	2,118,208,769	109.75	297.23	
1883	3,100,000,000			

Discounting the reported values of 1870, as has been done in preceding cases, we should have the corrected table as follows:

YEAR.	Corrected Amount of Capital Invested in Manufactures.	Corrected Gain per Cent in 10 Years.	Corrected Gain per Cent in 20 Years.	Corrected Gain per Cent in 33 Years.
1850	$533,245,351			
1860	1,009,855,715	89.38		
1870	1,694,567,015	67.80	217.70	
1883	3,100,000,000			

Again, we may take for comparison the amount of manufacturing wages paid in each of the years 1850, 1860, 1870, and 1883:

YEAR.	Amount of Manufacturing Wages Paid.	Gain per Cent in 10 Years.	Gain per Cent in 20 Years.	Gain per Cent in 33 Years.
1850	*$236,759,464			
1860	378,878,966	60.03		
1870	775,584,343	104.71	227.58	
1883	1,147,000,000			

* This is the true total. The one published is $236,755,464.

Should we discount the amount of wages paid in 1870 for the same reason and to the same extent as was done in the case of the gross product and the net product of that year, we should have the corrected table as follows:

YEAR.	Corrected Amount of Manufacturing Wages Paid.	Corrected Gain per Cent in 10 Years.	Corrected Gain per Cent in 20 Years.	Corrected Gain per Cent in 33 Years.
1850	$236,759,464			
1860	378,878,966	60.03		
1870	620,467,474	63.76	162.06	
1883	1,147,000,000			

If, again, we were to take the number of hands employed as the test of the manufacturing power of the country on the several dates named, we should have the following table:

YEAR.	Number of Hands Employed.	Gain per Cent in 10 Years.	Gain per Cent in 20 Years.	Gain per Cent in 33 Years.
1850	*958,079			
1860	1,311,246	36.86		
1870	2,053,996	56.64	114.39	
1883	2,975,000			

* This is the true total. The one published is 957,059.

In the above table we read an element which requires no allowance to be made on account of the state of the currency in 1870. The tremendous leap made by our manufacturing industries between 1860 and 1870, under the stimulus of war demand and war prices, forms a very striking feature of this table. Let us now put some of these separate elements together into a table for prompt and easy comparison:

	Gross Value of Manufactured Product.	Gross Value of Manufactured Product in 1870, Discounted by Premium on Gold.	Net Value of Manufactured Product.	Net Value of Manufactured Product in 1870, Discounted by Premium on Gold.
Per cent gain, 10 years, 1850–60*	85.05	85.05	84.13	84.13
Per cent gain, 10 years, 1860–70	124.42	79.54	104.14	63.31
Per cent gain, 10 years, 1870–80	26.87	58.59	13.12	41.40
Per cent gain, 20 years, 1860–80	184.73	184.73	130.93	130.93

	Capital Invested.	Capital Invested in 1870, Discounted by Premium on Gold.	Wages Paid.	Wages Paid in 1870, Discounted by Premium on Gold.	Hands Employed.
Per cent gain, 10 years, 1850–60*	89.38	89.38	60.03	60.03	36.86
Per cent gain, 10 years, 1860–70	109.75	67.80	104.71	63.76	56.64
Per cent gain, 10 years, 1870–80	31.73	64.66	22.22	52.78	33.04
Per cent gain, 20 years, 1860–80	176.30	176.30	150.20	150.20	108.40

* The true total of 1850 is used in casting these percentages.

THE GEOGRAPHICAL DISTRIBUTION OF OUR MANUFACTURING INDUSTRIES.

The geographical distribution of manufactures throughout the United States appears by the following tables, as was to be expected, to be governed by very different forces from those which control the distribution of population or of agricultural industry. The following table exhibits the rank of each State in the several respects of population, number of farms, aggregate value of farms, aggregate value of farm products, number of manufacturing establishments, aggregate value of manufacturing capital, and aggregate value of manufactured products:

States.	Rank in Population	Agricultural Rank. In Number of Farms	Agricultural Rank. In Aggregate Value of Farms	Agricultural Rank. In Aggregate Value of Products	Manufacturing Rank. In Number of Establishments	Manufacturing Rank. In Capital	Manufacturing Rank. In Value of Products
Alabama	17	15	28	16	29	30	32
Arkansas	25	19	30	21	33	37	36
California	24	----	----	----	----	----	----
Colorado	35	37	36	36	36	35	31
Connecticut	28	32	22	31	16	6	7
Delaware	37	35	34	35	35	24	28
Florida	34	33	37	34	37	36	37
Georgia	13	13	23	10	20	22	22
Illinois	4	1	3	1	4	5	4
Indiana	6	6	5	6	6	12	10
Iowa	10	7	6	4	11	18	19
Kansas	20	14	12	17	25	29	24
Kentucky	8	9	10	12	15	17	17
Louisiana	22	25	32	22	30	27	25
Maine	27	22	26	29	17	16	15
Maryland	23	26	18	26	12	14	13
Massachusetts	7	27	19	27	5	3	3
Michigan	9	12	7	8	7	8	9
Minnesota	26	21	15	19	21	19	16
Mississippi	18	18	27	13	31	34	35
Missouri	5	4	8	7	8	11	8
Nebraska	30	23	25	24	32	33	33
Nevada	38	38	38	38	38	38	38
New Hampshire	31	31	29	32	22	15	18
New Jersey	19	30	16	25	10	7	6
New York	1	3	2	2	1	1	1
North Carolina	15	11	20	18	19	26	29
Ohio	3	2	1	3	3	4	5
Oregon	36	34	36	33	34	32	34
Pennsylvania	2	5	4	5	2	2	2
Rhode Island	33	36	35	37	27	9	14
South Carolina	21	20	31	23	28	28	30
Tennessee	12	10	14	14	18	23	21
Texas	11	8	17	11	23	31	27
Vermont	32	29	24	28	24	21	23
Virginia	14	17	13	20	14	20	20
West Virginia	29	24	21	30	26	25	26
Wisconsin	16	16	9	9	9	10	11

CERTAIN INDUSTRIES EMPLOYING A LARGE PROPORTION OF WOMEN AND YOUNG CHILDREN.

Industry.	Total Persons Employed.	Per Cent of Males over 16 Years.	Per Cent of Females over 15 Years.	Per Cent of Children and Youth.
Bookbinding and blank-book making	10,612	48.31	45.53	6.16
Carpet weaving	20,371	49.60	42.07	8.33
Men's clothing	160,813	48.04	50.37	1.59
Women's clothing	25,192	10.30	88.33	1.37
Cotton goods	185,472	34.57	49.14	16.29
Men's furnishing goods	11,174	11.40	85.60	3.00
Hosiery and knit goods	28,885	26.02	61.30	12.68
Millinery and lace goods	6,555	14.81	80.06	5.13
Shirts	25,687	11.20	86.37	2.43
Silk and silk goods	31,337	29.92	52.32	17.76
Straw goods	10,948	29.94	68.52	1.54
Tobacco—chewing, smoking, and snuff*	32,756	45.44	32.90	21.66
Umbrellas and canes	3,608	41.69	51.52	6.79
Woolen goods	86,504	54.31	33.95	11.74
Worsted goods	18,803	34.22	50.38	15.40

*Oddly enough, women are not employed in anything like an equal proportion in the manufacture of cigars. The respective numbers are: Males above 16 years, 40,099; females above 15 years, 9,108; children, 4,090.

CERTAIN INDUSTRIES EMPLOYING A SMALL PROPORTION OF WOMEN AND CHILDREN.

Industry.	Total Persons Employed.	Per Cent of Males over 16 Years.	Per Cent of Females over 15 Years.	Per Cent of Children and Youth.
Agricultural implements	39,580	96.80	0.18	3.02
Bread and other bakery products	22,448	84.15	9.83	6.02
Brick and tile	66,350	88.97	0.40	10.63
Carriages and wagons	45,394	96.11	0.60	3.29
Drugs and chemicals	9,545	85.32	11.92	2.76
Dyeing and finishing textiles	16,698	76.58	12.21	11.21
Flour and grist mills	58,407	99.71	0.07	0.22
Furniture	48,729	92.73	1.88	5.39
Glass	24,177	73.53	3.07	23.40
Jewelry	12,697	79.15	15.74	5.11
Distilled liquors	6,502	99.23	0.15	0.62
Malt liquors	26,220	99.16	0.11	0.73
Musical instruments	11,350	96.26	1.54	2.20
Printing and publishing	58,478	78.46	11.56	9.98
Sewing machines and attachments	9,553	90.36	2.60	7.04
Tinware, copperware, and sheet-ironware	26,248	91.07	3.25	5.68

This widely different tendency of the various manufacturing industries, as to calling into service women and young children, naturally results in producing very different proportions in the same respects between the several States and the several cities, according as those industries which employ many women and children, or those which employ few, prevail.

The following table shows for each State, which produces to the value of $20,000,000, the proportions in which the several classes contribute to the aggregate body of persons employed in manufactures:

State.	Total Persons Employed.*	Per Cent of Males over 16 Years.	Per Cent of Females over 15 Years.	Per Cent of Children and Youth.
California	------------	------------	------------	----------
Connecticut	112,915	66.97	25.55	7.48
Delaware	12,638	81.11	11.28	7.61
Georgia	24,875	76.13	14.55	9.32
Illinois	144,727	83.30	10.53	6.17
Indiana	69,508	89.30	5.20	5.50
Iowa	28,372	89.46	5.04	5.50
Kansas	12,062	92.35	5.25	4.40
Kentucky	37,391	82.77	9.44	7.79
Louisiana	12,167	83.60	10.97	5.43
Maine	52,954	66.91	26.02	7.07
Maryland	74,945	62.31	28.95	8.74
Massachusetts	352,255	64.96	30.09	4.95
Michigan	77,591	88.21	6.17	5.62
Minnesota	21,247	89.13	7.70	3.17
Missouri	63,995	84.95	8.56	6.75
New Hampshire	48,831	60.12	33.14	6.74
New Jersey	126,038	68.86	21.50	9.64
New York	531,533	68.58	25.86	5.56
North Carolina	18,109	70.78	16.23	12.99
Ohio	183,609	82.90	10.11	6.99
Pennsylvania	387,072	73.46	18.87	7.67
Rhode Island	62,878	58.94	29.06	12.00
Tennessee	22,445	87.21	5.33	7.46
Texas	12,159	95.77	0.96	3.27
Vermont	17,540	82.31	12.95	4.74
Virginia	40,184	71.62	15.29	13.09
West Virginia	14,311	90.14	2.42	7.44
Wisconsin	57,109	84.50	10.93	4.57

*As by the tables of manufactures.

The tendency to variation in the respects under consideration is shown even more strikingly in the case of single cities. Thus, in giving the statistics of Pennsylvania as a whole, we merge Pittsburgh, a city which has a very low proportion of women and children employed in manufactures, with Philadelphia, a city which has a high proportion.

We therefore give in the table following the proportions in which the several classes, according to age and sex, contribute to the aggregate number of persons employed in manufactures in the fifty principal cities:

No.	Fifty Cities.	Total Persons Employed.*	Per Cent of Males over 16 Years.	Per Cent of Females over 15 Years.	Per Cent of Children and Youth.
1	New York, New York	227,352	64.30	31.58	4.12
2	Philadelphia, Pennsylvania	185,527	60.95	30.62	8.43
3	Chicago, Illinois	79,414	78.62	15.34	6.04
4	Brooklyn, New York	47,587	77.97	14.75	7.28
5	Boston, Massachusetts	59,213	67.23	30.65	2.12
6	Saint Louis, Missouri	41,825	81.24	11.38	7.38
7	Cincinnati, Ohio	54,517	71.52	19.23	9.25
8	Baltimore, Maryland	56,338	60.50	32.19	7.31
9	San Francisco, California	28,442	83.19	12.62	4.19
10	Pittsburgh, Pennsylvania	36,930	86.68	4.55	8.77
11	Newark, New Jersey	30,046	73.72	17.46	8.82
12	Jersey City, New Jersey	11,138	71.49	21.78	6.73
13	Cleveland, Ohio	21,724	82.94	10.52	6.54
14	Milwaukee, Wisconsin	20,886	76.68	18.78	4.54
15	Buffalo, New York	18,021	83.42	9.96	6.62
16	Providence, Rhode Island	22,891	70.11	23.39	7.50
17	Louisville, Kentucky	17,448	77.26	16.21	6.53
18	Lowell, Massachusetts	20,039	46.00	47.42	6.58
19	Detroit, Michigan	16,110	77.45	15.08	7.47
20	Minneapolis, Minnesota	5,344	87.99	8.55	3.46
21	Indianapolis, Indiana	10,000	86.71	8.30	4.99
22	Worcester, Massachusetts	16,559	82.64	14.98	2.38
23	Lynn, Massachusetts	12,420	71.61	28.09	0.30
24	Cambridge, Massachusetts	7,543	82.26	15.54	2.20
25	Paterson, New Jersey	19,799	51.87	33.21	14.92
26	Troy, New York	22,434	46.08	49.54	4.38
27	Rochester, New York	14,607	63.61	27.74	8.65
28	Lawrence, Massachusetts	16,719	46.77	47.30	5.93
29	New Haven, Connecticut	15,156	65.97	31.54	2.49
30	Albany, New York	11,785	83.40	12.97	3.63
31	Richmond, Virginia	14,047	65.62	20.45	13.93
32	Fall River, Massachusetts	17,085	48.18	39.35	12.47
33	New Orleans, Louisiana	9,504	80.66	13.53	5.81
34	Syracuse, New York	10,966	68.51	26.18	5.31
35	Peoria, Illinois	4,067	88.98	7.70	3.32
36	Manchester, New Hampshire	10,838	42.74	53.03	4.23
37	Alleghany, Pennsylvania	6,471	85.75	9.49	4.76
38	Holyoke, Massachusetts	9,011	49.19	42.85	7.96
39	Reading, Pennsylvania	6,695	80.85	10.81	8.34
40	Wilmington, Delaware	7,852	87.51	5.84	6.65
41	Springfield, Massachusetts	7,360	66.32	29.05	4.63
42	Trenton, New Jersey	8,902	75.16	12.18	12.66
43	Dayton, Ohio	6,025	84.17	8.51	7.32
44	Washington, District Columbia	7,146	76.91	19.44	3.65
45	Hartford, Connecticut	6,300	72.59	21.79	5.62
46	Toledo, Ohio	6,738	74.62	15.14	10.24
47	Bridgeport, Connecticut	7,508	72.93	24.07	3.00
48	Saint Paul, Minnesota	5,230	75.14	20.88	3.98
49	Salem, Massachusetts	4,181	62.95	31.31	5.74
50	New Bedford, Massachusetts	5,812	67.36	26.46	6.18

*As by the tables of manufactures.

NATIONALITY IN MANUFACTURING INDUSTRY.

The comparative aptitude of our foreign population as a whole for the several grand classes of occupations may be seen by looking at the following table, derived from the statistics of occupations:

Grand Class of Occupations.	Total.	Per cent of persons engaged who are natives of the United States.	Per cent of persons engaged who are natives of all foreign countries.
All occupations	100	79.91	20.09
Agriculture	100	89.40	10.60
Professional and personal services	100	75.52	24.48
Trade and transportation	100	74.67	25.33
Manufacturing, mechanical, and mining	100	68.05	31.95

From this it appears that persons of foreign birth constitute a larger part of the total number of persons employed in manufacturing, mechanical, and mining pursuits than is the case in any other of the grand class of gainful occupations.

As between the different industries embraced in this great class, the foreign element shows very different aptitudes.

The following table shows for each recognized occupation within this class, which employs as many as 20,000 persons, first, the proportion in which the total number of operatives engaged is made up of persons of native and persons of foreign birth; and, secondly, the proportions in which the total number of persons of foreign birth engaged is made up from the different foreign countries on the list:

Industries.	Operatives.			Foreign per Cent of each Class.						
	Total.	Per Cent of Native.	Per Cent of Foreign.	Total.	Ireland.	Germany.	Great Britain.	Scandinavia.	British America.	Other Countries.
Apprentices to trades	100	90.76	9.24	100	14.55	32.09	18.03	4.00	13.45	17.83
Bakers	100	43.84	56.16	100	11.53	65.68	7.85	1.23	4.18	9.53
Blacksmiths	100	72.71	27.29	100	27.04	32.10	15.93	4.78	12.03	7.22
Boot and shoemakers	100	64.24	35.76	100	25.13	40.09	9.66	3.62	10.92	10.58
Brick and tile makers	100	68.17	31.83	100	20.28	27.21	7.74	4.04	30.04	10.69
Butchers	100	61.66	38.34	100	11.92	62.15	10.67	.99	3.84	10.43
Cabinet makers	100	58.23	41.77	100	5.35	63.00	6.91	5.99	6.71	12.04
Carpenters and joiners	100	77.04	22.96	100	16.55	35.46	15.41	6.20	17.55	8.73
Carriage and wagon makers	100	75.45	24.55	100	11.36	50.57	11.58	4.44	12.99	9.06
Cigar makers	100	55.43	44.57	100	3.38	47.48	5.61	.82	2.08	40.63
Coopers	100	67.09	32.91	100	20.25	54.79	5.00	2.34	8.18	9.41
Cotton mill operatives	100	55.37	44.63	100	26.04	2.64	21.43	.37	48.03	1.49
Employés in manufacturing establishments	100	71.56	28.44	100	26.97	33.65	16.86	2.00	8.85	11.67
Engineers and firemen	100	72.82	27.18	100	32.28	19.94	30.27	2.41	9.15	5.95
Fishermen and oystermen	100	73.33	26.67	100	9.39	6.94	5.27	8.28	25.53	44.59
Gold and silver workers and jewelers	100	72.91	27.09	100	12.01	42.27	20.17	3.24	5.73	16.58
Harness and saddle makers	100	74.50	25.50	100	19.29	43.11	11.08	2.38	11.91	12.23
Iron and steel workers and shop operatives	100	63.67	36.33	100	40.21	22.37	24.45	2.51	5.38	5.13
Leather curriers, dressers, finishers, and tanners	100	54.26	45.74	100	44.16	30.13	6.92	3.19	8.53	7.06
Lumbermen and raftsmen	100	65.82	34.18	100	8.42	9.36	7.13	12.56	53.78	8.75
Machinists	100	69.88	30.12	100	20.70	26.94	32.26	3.20	9.04	7.87
Manufacturers	100	73.73	26.27	100	12.51	43.86	23.20	1.32	6.07	13.03
Marble and stonecutters	100	55.41	44.59	100	42.51	19.76	21.91	1.75	7.43	7.01
Masons, brick and stone	100	64.63	35.37	100	34.79	32.71	15.83	3.65	6.15	6.87
Mill and factory operatives	100	74.21	25.79	100	26.74	21.20	23.82	3.05	16.11	9.38
Millers	100	84.63	15.37	100	10.94	41.07	23.72	4.41	10.93	8.93
Milliners, dressmakers, and seamstresses	100	83.95	16.05	100	35.36	20.30	15.51	3.62	15.39	9.82
Miners	100	46.11	53.89	100	20.17	7.94	37.58	3.82	4.50	25.99
Painters and varnishers	100	76.05	23.95	100	20.06	33.33	20.57	5.71	10.19	10.14
Paper mill operatives	100	66.80	33.20	100	52.75	9.88	16.95	1.13	15.19	5.10
Plasterers	100	72.44	27.56	100	43.17	20.05	20.08	2.68	8.00	6.02
Printers, lithographers, and stereotypers	100	83.00	17.00	100	22.96	27.00	25.39	2.99	13.41	8.25
Saw and planing mill operatives	100	73.29	26.71	100	8.33	24.13	5.43	14.30	33.69	14.06
Tailors and tailoresses	100	46.48	53.52	100	14.38	52.65	7.01	5.67	3.26	17.06
Tinners and tinware makers	100	75.86	24.14	100	17.73	44.59	15.42	3.03	8.99	10.24
Tobacco factory operatives	100	91.31	8.69	100	22.66	37.33	7.94	1.69	4.62	25.79
Woolen mill operatives	100	60.72	39.28	100	36.85	10.88	30.36	1.39	17.63	2.83

Pages might be written of appropriate comment upon the foregoing table. Thus, bearing in mind that the number of Germans engaged in all branches of productive industry is to the number of Irish as 13 to 10, we find more than 5 Germans to 1 Irishman; as cabinet makers, 12 to 1; as cigar makers, 14 to 1. On the other hand there are 10 Irish in cotton mills to 1 German.

Although British Americans are only about one half the Irish engaged in manufacturing and mechanical pursuits, and are considerably less than one half the Germans, there are more of British Americans in saw and planing mills, and in cotton mills, than of Germans and Irish combined, while British Americans as lumbermen and raftsmen exceed the men of all other nationalities from whatever quarter of the globe.

These various industrial aptitudes of the men of the several nationalities appearing in our tables naturally cause those nationalities to be represented in very different proportions in the several cities, States, and sections.

The following table gives the proportions in which the industrial classes of each State producing to the value of $20,000,000 (manufactures) are divided (1) between persons of native and persons of foreign birth, and (2) the proportions in which the aggregate foreign born class is divided among the several nationalities recognized in the tables of occupations:

States.	Population	All persons engaged in Manufacturing, Mechanical, and Mining Industries.			Total per Cent	Per Cent of Persons of Foreign Birth engaged in Manufacturing, Mechanical, and Mining Industries, Born in—					
		Total per Cent	Per Cent Native	Per Cent Foreign		Ireland	Germany	Great Britain	Scandinavia	British America	Other Countries
The United States	50,155,783	100	68.05	31.95	100	23.18	30.03	18.42	3.64	12.56	12.17
California	864,694	100	40.65	59.35	100	13.77	13.30	12.63	2.22	7.41	50.67
Connecticut	622,700	100	67.59	32.41	100	42.36	13.55	19.85	2.05	18.71	3.48
Delaware	146,608	100	87.13	12.87	100	47.12	18.78	25.97	1.04	1.87	5.22
Georgia	1,542,180	100	96.52	3.48	100	31.90	29.00	21.72	2.47	3.03	11.88
Illinois	3,077,871	100	56.67	43.33	100	13.80	40.85	17.35	11.76	5.63	10.61
Indiana	1,978,301	100	81.70	18.30	100	12.00	57.79	16.37	1.94	3.25	8.65
Iowa	1,624,615	100	71.75	28.25	100	10.46	41.34	19.27	11.32	7.57	10.04
Kansas	996,096	100	78.64	21.36	100	12.80	30.16	26.77	10.34	9.37	10.56
Kentucky	1,648,690	100	81.72	18.28	100	18.72	59.32	12.38	0.24	2.11	7.24
Louisiana	936,946	100	74.40	25.60	100	15.85	40.74	6.95	0.82	1.83	33.78
Maine	648,936	100	82.19	17.81	100	15.58	1.59	18.57	1.23	60.48	2.55
Maryland	934,943	100	79.38	20.62	100	15.27	65.05	12.44	0.28	1.31	5.65
Massachusetts	1,783,085	100	64.35	35.65	100	39.66	4.65	18.67	1.48	32.72	2.82
Michigan	1,636,937	100	56.57	43.43	100	9.19	23.85	16.88	5.71	34.62	9.75
Minnesota	780,773	100	52.44	47.56	100	7.18	28.86	8.39	28.99	17.93	8.65
Missouri	2,168,380	100	68.06	31.94	100	16.77	55.25	12.00	1.66	3.71	10.61
Nebraska	452,402	100	69.64	30.36	100	10.01	35.47	17.35	11.71	9.87	15.59
New Hampshire	346,991	100	72.71	27.29	100	20.72	1.78	10.96	0.42	65.22	0.90
New Jersey	1,131,116	100	68.32	31.68	100	28.57	36.04	23.76	1.00	1.76	8.87
New York	5,082,871	100	61.23	38.77	100	28.87	38.14	13.93	1.41	6.48	11.17
North Carolina	1,399,750	100	98.02	1.98	100	14.02	14.74	22.54	1.59	3.32	43.79
Ohio	3,198,062	100	71.03	28.97	100	11.69	50.82	22.29	0.54	4.48	10.18
Pennsylvania	4,282,891	100	73.60	26.40	100	31.02	30.55	29.14	1.61	1.80	5.85
Rhode Island	276,531	100	60.88	39.12	100	35.19	2.65	27.28	1.09	31.83	1.96
Tennessee	1,541,359	100	92.97	7.03	100	25.32	28.75	26.26	3.15	3.00	13.52
Texas	1,591,749	100	74.01	25.99	100	12.06	36.59	13.52	2.47	3.94	31.42
Vermont	332,286	100	75.30	24.70	100	23.66	1.74	13.96	0.39	58.74	1.51
Virginia	1,512,565	100	97.04	2.96	100	23.45	33.78	27.09	1.07	3.05	11.56
West Virginia	618,457	100	86.96	13.04	100	25.39	42.52	25.79	0.20	2.22	3.88
Wisconsin	1,315,497	100	51.88	48.88	100	5.90	49.33	9.97	11.43	10.54	12.83

CHAPTER II.

COST OF LIVING, ETC.

GREAT BRITAIN AND IRELAND.

England.

The manufacturing supremacy of England has necessarily developed a great labor element in that country, and it may be said that, as England has led the nations in commerce and manufacture, her artisans, mechanics, and workingmen in general, have also led the labor element of Europe.

Rates of Wages.—In laying before you the following statements showing the rates of wages, as averaged from the reports herewith submitted, throughout England, as compared with those prevailing in New York, Chicago, and San Francisco, it should be remarked that in many cases the English workingman appears to receive a comparatively high rate of wages. He only works on half, or two thirds time, thus gratifying his desire to preserve a high rate of wages at the expense of time; a sentimental fiction which is neither profitable nor substantial.

Statement showing the Weekly Rates of Wages Paid the following Trades in England and the Rates Paid to similar Trades in New York, Chicago, and in San Francisco.

Occupations.	England.	New York.	Chicago.	San Francisco.
Bricklayers	$8 12	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	8 16	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	8 25	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	7 25	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	7 25	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	8 10	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	7 75	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Slaters	7 90	10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
Blacksmiths	8 12	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	6 50	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	7 83	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	7 35	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Butchers	7 23	8 00 to 12 00	12 00 to 18 00	12 00 to 18 00
Cabinet makers	7 70	9 00 to 13 00	7 00 to 15 00	13 50 to 18 00
Coopers	7 30	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths	7 40	12 00 to 15 00	15 00 to 21 00	13 50 to 18 00
Cutlers	8 00	10 00 to 13 00	----------------	11 50 to 16 50
Engravers	9 72	15 00 to 25 00	9 00 to 30 00	18 00 to 30 00
Horseshoers	7 20	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Millwrights	7 50	10 00 to 15 00	12 00 to 21 00	21 00 to 30 00
Printers	7 75	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers	6 80	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers	7 30	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Tinsmiths	7 30	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Tailors	5 00 to 7 30	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Brass finishers	7 40	10 00 to 14 00	8 00 to 15 00	15 00 to 21 00
Laborers, porters, etc.	5 00	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

That you may be able to make fuller comparison of the relative purchasing power of the wages of the English and American workingmen, I submit the following table, showing the food prices as averaged from all the English reports and the prices in New York, Chicago, and San Francisco:

Statement Showing the Retail Prices of the Necessaries of Life in England and the United States.

Articles.	England—In Cents.	New York—In Cents.	Chicago—In Cents.	San Francisco—In Cents.
Bread, per pound	3½ to 4½	4 to 4½	4 to 4½	*5 to 10
Flour, per pound	3½ to 4½	3 to 4½	2½ to 4½	2½ to 3
Beef—				
For roasting, per pound	22	12 to 16	8 to 12½	12 to 15
For soup, per pound	15	6 to 8	5	6 to 10
Rump steak, per pound	26½	14 to 16	8 to 12½	15 to 20
Corned, per pound	18	8 to 12	4 to 7	10 to 15
Veal—				
Forequarters, per pound	18	9 to 10	6 to 10	8 to 12
Hindquarters, per pound	22½	12 to 14	10 to 12	12 to 18
Cutlets, per pound	27	14 to 16	12½ to 15	15
Mutton—				
Forequarters, per pound	17	9 to 10	5 to 12½	7 to 8
Hindquarters, per pound	22	12 to 14	5 to 15	12 to 15
Chops, per pound	25	14 to 16	10 to 15	15 to 18
Pork—				
Fresh, per pound	16½	8 to 10	4 to 8	15 to 18
Salted, per pound	15	8 to 10	6 to 12	10 to 15
Bacon, per pound	12 to 16	8 to 10	7 to 12	12 to 15
Ham, per pound	13½ to 23	8 to 12	7 to 15	14 to 16
Shoulder, per pound	12	8 to 10	4 to 10	10 to 15
Sausage, per pound	18	8 to 10	6 to 10	15 to 20
Lard, per pound	15 to 18	10 to 12	6 to 10	12 to 15
Codfish, dry, per pound	8	6 to 7	5 to 9	10 to 15
Butter, per pound	29 to 38	25 to 32	16 to 40	30
Cheese, per pound	15 to 21	12 to 15	5 to 16	15 to 25
Potatoes, per bushel	112 to 200	112 to 160	60 to 80	†100 to 150
Rice, per pound	3½ to 8	8 to 10	5 to 10	6
Beans, per quart	9	7 to 10	5 to 9	6
Milk, per quart	6 to 9	8 to 10	3 to 6	10
Eggs, per dozen	19 to 30	25 to 30	10 to 24	20 to 30
Oatmeal, per pound	3½ to 4	4 to 5	4 to 5	4 to 6
Tea, per pound	43 to 88	50 to 60	25 to 100	70
Coffee, per pound	28 to 42	20 to 30	15 to 40	25 to 35
Sugar, per pound	5½ to 9	8 to 10	7 to 11	8½ to 10
Soap, per pound	5¼ to 9	6 to 7	3 to 8	7 to 10
Starch, per pound	10 to 12	8 to 10	5 to 10	9 to 10
Coal, per ton	320 to 410	525	300 to 675	8 to 16

* Per loaf. † Per 100 pounds.

It will be seen, that while wages in New York, Chicago, and San Francisco are about twice the average wages throughout England, the prices of the necessaries of life are lower in those two cities than the average prices throughout England.

It is well that your attention should be specially drawn to the erroneous opinions which have more or less prevailed, especially in the minds of our working people in the United States for the past few years, that wages were higher and the cost of living less in England than in this country.

At a time of unusual depression in all trades in the United States, strikes of certain trades occurred in England. Some British manufacturers, taking advantage of the occasion, induced a number of working men from this side to go over and take the places of the English working men on strike.

This gave rise to the idea, that work was more easily obtained, and that wages were higher, in that country than in the United States.

It may be remarked, that the principal portion of those workingmen were natives of Great Britain, many of them immigrants newly arrived in the United States, and all of them out of employment.

The few Americans who did go were repaid for their venture by much humiliation and suffering, as the many reports from our Consuls in England have testified; so that there is scarcely any need to refute the foregoing fallacy by any further consular testimony; but the Consul at Bristol puts the question in so graphic a manner, that I cannot refrain from quoting his words:

> No laborer should allow himself to be enticed, by imagining that he could better his condition by leaving the United States to return to his native country, if born in Europe. A number of such laborers, and also some mechanics, have, during the last two years, called upon this consulate for help to get back to the United States, cursing the day when they left America for Europe, where neither milk nor honey is flowing. *Compared with Europe, the United States is a paradise for a sober and faithful workingman.*

In regard to the question of food-prices in England and in the United States, no stronger argument can be advanced to dissipate the idea that workingmen can live cheaper in that country than in this, than the fact that Great Britain imported from the United States, during a recent year, "necessaries of life" to the following amounts: Wheat, $50,000,000; Indian corn, $300,000; flour, $8,300,000; lard, $6,800,000; pork, salted, $3,000,000; butter, $2,870,000; fresh beef, $2,000,000; refined sugar, $1,650,000; pease, $1,500,000; canned and preserved meats, $1,400,000; fruits, raw, $1,243,000; molasses, $653,000; coffee, $516,000; oats, $343,000; barley, $264,000—a total food-supply of over $171,000,000!

In regard to the food-living of the English workingman it may be said that it is regulated solely by his ability to buy; he will have as much strong and wholesome food—and he is a good eater—as he can purchase, meat entering into his fare more plentifully than into the fare of any other workingman in Europe.

The Consul at Bristol says that the English workingman of to-day eat fully three times more meat than the English workingman of twenty years ago. It may, also, be remarked that American bacon is largely used by the English workingman, as also other American meats when they can be purchased.

There would seem to be no disposition to lay anything by for the "rainy day," the English workingman never stinting himself in his food, as on the Continent, for the purpose of laying by a reserve. This disposition of living each day in itself—coupled with the periodic strikes, which break up the even run of wages and bring so much suffering to his wife and children—renders the life of the English workingman a spasmodic struggle for existence; and it may be doubted whether the family of the average English laborer or mechanic is any better off, year in and year out, than the family of the German or French laborer or mechanic. It certainly has not that sentimental and musical enjoyment which throws such pictorial light about the poor man's home in the latter countries.

The weekly wages, as averaged from these reports, of agricultural laborers throughout England, are as follows:

Men, without board or lodging	$4 25
Men, with board and lodging	$1 50 to 2 40
Women, without board or lodging	1 80 to 3 20
Women, with board and lodging	0 60 to 1 05
Women, house servants, per annum	$34 00 to $49 00

IRELAND.

No country in Europe, perhaps, affords a better illustration of the commercial vigor and manufacturing activity which are ever the results of diversified industry than does Ireland by the almost total absence of the same, and the consequent monotony which is ever the accompaniment of such a commercial condition as prevails in that country.

With the exception of the linen manufacture, omitting local efforts for self-supply, Ireland may be said to have no national industry outside of agriculture; and as the great tendency of agriculture in that country is toward pasture farming—over one third of all the arable land being now given up to pasturage and meadow land—and as the labor required to tend cattle and cut and save hay is comparatively little, it follows that even the requirements of this one industry, as far as labor is concerned, must be growing less year by year.

Emigration, however, would seem to draw off Ireland's surplus labor population, as the wages of farm hands in that country, according to the reports submitted, are very little less than the wages which prevail in England and Scotland, as may be seen by the following statement:

Weekly Wages Paid to Agricultural Laborers in Ireland, England, Scotland, and California.

Description.	Ireland.	England.	Scotland.	California.
Men, without board or lodging	$3 40	$3 60	$4 25	$7 50 to $9 00
Men, with board and lodging	1 30	2 60	$1 50 to 2 00	6 00
Women, without board or lodging	2 16	1 80	1 80 to 3 25	7 00
Women, with board and lodging	0 75	1 15	0 60 to 1 00	5 00
Women, house servants, per year	40 00	60 00	34 00 to 49 00	240 00

In a large number of cases, the agricultural laborers of Ireland supplement their wages by the produce of small plots of ground attached to their cabins. As a general thing, a fair share of the field work is performed by women.

To enable you to compare the rates of wages paid to the trades in Ireland with the rates paid to similar trades in New York, Chicago, and San Francisco, I submit the following table:

Statement showing the Weekly Wages Paid by the Board of Public Works throughout Ireland to the Building Trades and the General Rates Paid similar Trades in New York, Chicago, and San Francisco.

Building Trades.	Ireland.	New York.	Chicago.	San Francisco.
Bricklayers	$7 58	$12 00 to $15 00	$6 00 to $10 50	$24 00 to $30 00
Masons	7 58	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	7 33	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	7 95	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	7 54	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	7 68	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	8 46	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00

Food and Food Prices.—In regard to the food prices in Ireland and in the United States, it is enough to say that the principal part of the food used by the workingmen of Ireland comes from the United States.

In regard to the manner and cost of living of the working people, the Consul at Cork says: "The food is made up of a selection from tea, bread, oatmeal, potatoes, dried fish, and among the poorer classes, a coarse Indian meal instead of oatmeal, at an average expense to each person of 14 cents per day. The mechanic pays something more for his lodging, but in other respects his living is the same as the laborer."

The Consul at Londonderry writes: "The food of all laborers here is Indian meal (principally), oatmeal, potatoes, and bacon next. Tea may be said to be in universal use."

With wages almost equal to those paid in England and Scotland, the food of the working people of Ireland is much inferior to the food of the English working people, lacking the solidity of meat, cheese, beer, etc., consumed in such comparatively large proportions by the latter. The English are also better clothed and lodged, the air of thrift and comfort which is so apparent in the homes of the English mechanic, being almost totally unknown to the hard-working Irishman. Much of this undoubtedly arises from the diversity of industries in England, many members of the same family finding employment in mills and factories, etc., and thus helping to swell the general fund, while the single earning of the head of the family in Ireland, as a general rule, has to support the whole. The Consul at Belfast says that with the prevalent rates of wages the mechanic or laborer can save nothing.

SCOTLAND.

I take pleasure in calling your attention to the very interesting and comprehensive reports from the several Consulates in Scotland, which have fully answered all the requirements of the department circular.

The agricultural capacity of Scotland is, perhaps, more limited, according to area, than any other country in Europe, but it is doubtful whether the agriculture of any other country has been prosecuted with more educated skill and industry.

The intelligence which was brought to the aid of agriculture in Scotland at a time when intelligence was the exception, and not considered essential to that industry, has made Scotch farming synonymous with all that is advanced in agriculture.

This intelligence, common, as a rule, to employer and employé, makes these reports, where they treat of agriculture, specially interesting.

Rates of Wages.—The average weekly wages of agricultural laborers in Scotland are as follows—although it is necessary to read the particular reports, in order to arrive at a true understanding of the special advantages and disadvantages of Scottish rural life, no two districts being alike in habits and customs:

Men, without board or lodging	$3 60
Men, with board and lodging	2 60
Women, without board or lodging	1 80
Women, with board and lodging	1 15
Women, house servants, per annum	60 00

Agricultural wages in Scotland have increased ten per cent during the last five years, and twenty-five per cent during the last fifteen years.

In regard to the manner of life of the agricultural laborers, I would specially refer to that part of Consul Robeson's report which treats upon the subject. Their food consists of oatmeal, milk, and potatoes, with a little meat and beer sometimes added. The Consul remarks, that were it not for extravagance in dress the Scotch farm laborers could save considerable money, and that on the whole, they are the opposite of saving and thrifty.

In turning from the agricultural to the mechanical and manufacturing classes in the great trade centers of Scotland, it will be noted, by comparison, that wages seem to be a trifle higher than the rates prevailing in England; but if the great depression in the manufacturing interests of Scotland are taken into consideration, together with consequent short time and enforced idleness, it might be questioned whether the average rates of wages in Scotland would equal those of England.

Statement showing the Weekly Wages Paid the following Trades in Scotland and the Rates Paid to similar Trades in New York, Chicago, and San Francisco.

Occupation.	Scotland.	New York.	Chicago.	San Francisco.
Bricklayers	$9 63	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	8 28	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	8 12	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	8 40	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	8 16	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	10 13	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	7 13	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Slaters and lathers	8 30	10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
Blacksmiths	7 04	10 00 to 18 00	9 00 to 12 00	12 00 to 24 00
Bakers	6 63	5 00 to 8 00	8 00 to 12 00	12 00 to 18 00
Bookbinders	6 52	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	7 35	8 00 to 12 00	9 00 to 18 00	12 00 to 18 00
Butchers	4 75	9 00 to 13 00	12 00 to 18 00	12 00 to 18 00
Cabinet makers	8 48	12 00 to 16 00	7 00 to 15 00	13 50 to 18 00
Coopers	6 10	12 00 to 15 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths	7 13	10 00 to 13 00	15 00 to 21 00	13 50 to 18 00
Cutlers	6 25	15 00 to 25 00	----------	11 50 to 16 50
Engravers	8 75	12 00 to 18 00	9 00 to 30 00	18 00 to 30 00
Horseshoers	7 00	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Millwrights	7 50	10 00 to 15 00	15 00 to 21 00	21 00 to 30 00
Printers	7 52	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harness makers	6 15	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers	6 33	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Tinsmiths	6 00	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Tailors	7 00	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Brass founders	6 92	10 00 to 14 00	8 00 to 15 00	15 00 to 21 00
Laborers, porters, etc.	4 50	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

While the foregoing table shows the rates of wages in New York, Chicago, and San Francisco to be on an average once and a half as much as the rates in Scotland, the prices of the necessaries of life are higher in Scotland than in the United States. The Consul at Glasgow says that rent, clothing, bread, sugar, tea, and coffee are about the same in that city as in New York.

Habits of the Workingmen.—In regard to the habits of the mechanical and manufacturing classes in the cities and trade centers of

Scotland, it may be said that their besetting sin is whisky drinking, and that to this, and to its great ally, strikes, may be attributed the greater part of the misery and degradation which afflict the labor population.

In speaking of the necessaries of life, the Consul at Glasgow says: "Whisky, which is here considered a positive necessity by the great mass of laborers, and which costs about three hundred per cent more than in the United States, and beer, which is comparatively cheap and bad, absorb the larger portions of the laborers earnings."

Of the evils resulting from strikes, the Consul at Leith writes: "Strikes are of frequent occurrence in all trades, but, as a rule, they result in impoverishing the workman, who has, in the end, to return to his previous wages, or accept his employer's terms."

The rates of wages are at present seven per cent higher throughout Scotland than they were five years ago, but the increase in the cost of living has more than neutralized the increase of wages. The Consul at Glasgow is inclined to the belief that, if the present stagnation continues, wages will recede to even less than the rates of wages five years ago.

GERMANY.

Rates of Wages.—To enable you to compare the rates of wages paid in Germany with the rates prevailing in New York, Chicago, and in San Francisco, I herewith submit a statement showing the weekly wages earned, as averaged from the several reports in Germany, and the rates paid in those three cities:

Weekly Wages in Germany, New York, Chicago, and San Francisco.

Occupations.	Germany.	New York.	Chicago.	San Francisco.
Bricklayers	$3 45	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	4 00	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	4 18	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	3 95	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	4 60	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	4 35	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	3 90	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Slaters	3 90	10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
Blacksmiths	3 90	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	3 90	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	3 90	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	4 32	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Butchers	4 20	8 00 to 12 00	12 00 to 18 00	12 00 to 18 00
Cabinetmakers	4 95	9 00 to 13 00	7 00 to 15 00	13 50 to 18 00
Coopers	4 35	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths	3 90	12 00 to 15 00	15 00 to 21 00	13 50 to 18 00
Cutlers	3 90	10 00 to 13 00	-----	11 50 to 16 50
Engravers	4 00	15 00 to 25 00	9 00 to 30 00	18 00 to 30 00
Horseshoers	3 50	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Millwrights	4 95	10 00 to 15 00	15 00 to 21 00	21 00 to 30 00
Printers	3 90	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harness makers	3 90	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers	3 90	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Tinsmiths	3 60	10 00 to 14 00	9 00 to 18 00	15 00 to 21 00
Tailors	4 30	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Brass founders	5 50	10 00 to 14 00	8 00 to 15 00	15 00 to 21 00
Laborers, porters, etc.	2 60	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

To enable you to carry the comparison still further, I submit a table showing the food-prices in Germany and in the United States:

Statement showing the Retail Prices of the Necessaries of Life in Germany, and the Prices of similar Articles in New York, Chicago, and in San Francisco.

Articles.	Germany—In Cents.	New York—In Cents.	Chicago—In Cents.	San Francisco—In Cents.
Bread, per pound	3 to 7	4 to 4½	4 to 4½	*5 to 10
Flour, per pound	5½	4½ to 5	2½ to 4½	2½ to 3
Beef—				
Roast, per pound	22	12 to 16	8 to 12½	12 to 15
Soup, per pound	14	6 to 8	5	6 to 10
Rump, per pound	14	14 to 16	8 to 12½	15 to 20
Corned, per pound	13	8 to 12	4 to 7	10 to 15
Veal, per pound	14	8 to 12	6 to 12	10 to 15
Mutton, per pound	14½	9 to 14	5 to 15	7 to 18
Pork—				
Fresh, per pound	17	8 to 10	4 to 8	15 to 18
Salted, per pound	17	8 to 10	6 to 12	10 to 15
Bacon, per pound	20	8 to 10	7 to 12	12 to 15
Ham, per pound	20	8 to 12	7 to 15	14 to 16
Shoulder, per pound	19	8 to 10	4 to 10	10 to 15
Sausage, per pound	21	8 to 10	5 to 10	15 to 20
Lard, per pound	21	10 to 12	6 to 10	12 to 15
Butter, per pound	22	25 to 32	16 to 40	30
Cheese, per pound	24	12 to 15	5 to 16	15 to 25
Rice, per pound	9	8 to 10	5 to 10	6
Beans, per quart	10	7 to 10	5 to 9	6
Milk, per quart	4	8 to 10	3 to 6	10
Oatmeal, per pound	8	4 to 5	4 to 5	4 to 6
Tea, per pound	75	50 to 60	25 to 75	70
Coffee, per pound	35	20 to 30	15 to 40	25 to 35
Sugar, per pound	11	8 to 10	7 to 11	8½ to 10
Soap, per pound	10	6 to 7	3 to 8	7
Starch, per pound	9	8 to 10	5 to 10	9
Coal, per ton	4 25	5 25	3 00 to 6 75	8 00 to 10 00

* Per loaf.

It will be seen by the foregoing tables, that while the rates of wages in New York, Chicago, and San Francisco, are, on an average, three times the rates in Germany, the prices of the necessaries of life in those three cities are much less than the average prices for all Germany.

Assuming that, whenever the German workman can buy the greater part of the articles mentioned in the foregoing list, he buys the cheapest, the difference in favor of the American workingman is very marked.

The average weekly wages of the agricultural laborers of Germany are as follows:

Men, without board or lodging	$3 50
Men, with board and lodging	1 80
Women, without board or lodging	1 55
Women, with board and lodging	60

FRANCE.

There is no country in Europe whose labor habits and systems are more worthy of careful investigation than are those of France.

The French working people have, more truly than any other work ing people, illustrated that commendable phase of political economy getting the greatest possible result out of the most limited means. They look squarely and sensibly at their capital, and then limit their requirements within that capital; make the most and best of their lot, and fling a halo of sentiment about their lives of toil. For these reasons, the work-people of France, with as little remuneration and as scanty fare as those of almost any other country—much less than any of their neighbors—are the happiest and most contented labor population in Europe.

Rates of Wages.—Although the reports herewith submitted may not afford in all cases an exactly correct review of the wages prevailing throughout France, in other respects—customs and habits of the people and their modes of living—they will be found full and interesting.

In regard to agriculture—the greatest industry in France, comprising ten million land owners, over eighteen million, large and small, of the population being engaged therein—the average rate of wages is computed from the reports from Bordeaux, La Rochelle, Lyons, Nice, and St. Etienne.

The highest rate in any of these five reports are quoted for Bordeaux and La Rochelle, viz.: $3 60 per week, for men, without board or lodging; and the lowest from Lyons, $1 75 per week, without board or lodging.

The district of the Seine is not included in the rates here given; the agriculturists therein being engaged principally in market farming for Paris.

For this reason the agricultural wages given in the report of the Consul-General are exceptionally high, and if given with the five other reports would result in showing an unfair average.

The weekly wages, therefore, paid to agricultural laborers throughout France may be set down as follows:

Men, without board or lodging	$3 15
Men, with board and lodging	1 36
Women, without board or lodging	1 10

There is scarcely any necessity for saying that the French farm laborer must practice the closest economy to enable him to support himself and family on the foregoing wages. Not only does he do this, but in many cases he saves enough to work himself into independent proprietorship in the land. How this is accomplished must be a matter of such general interest as to excuse a somewhat detailed account thereof.

The Consul at Bordeaux, Department of the Gironde, writes: "The farm laborers are frequently economical to avariciousness, and many of them, in the course of time, become quite wealthy proprietors."

In many districts in France the laborers supplement their agricultural earnings by secondary employments, such as weaving, wood-cutting, sawing, wooden-shoe making, etc. The Consul at Lyons says that from 8 to 10 per cent of the agricultural laborers in his district are engaged in these secondary employments, which yield to each laborer about $40 per annum.

Not only must the husband labor for the support of his family, but the wife and children must also labor for the general fund in order to make ends meet. The Lyons report gives a most interesting insight into the economies which enter into the yearly subsistence of the French agricultural laborer's family, and one cannot help being struck with the amount of sobriety, patience, and mutual sacrifices which the insight displays. Had this same economy and patient industry the scope and plentifulness which the more generous agricultural opportunities of the United States afford, to what happy results would it not lead?

The married farm laborer, who supports and lodges himself, may earn in the Lyons district $150 per annum, divided as follows: Husband's wages, $80; wife's wages, $30; children's wages, $40.

The cost of living to such a family, per annum, is calculated as follows:

Rent	$10 50
Bread	55 00
Meat	10 00
Vegetables	8 25
Wine, beer, and cider	7 00
Milk	5 25
Clothing	25 00
Groceries	10 00
Fuel	8 00
Taxes	2 00
Total	$141 00

An average struck from all the reports—seven in number—gives the following results in regard to the rates of wages paid to the several trades in France; the rates paid similar trades in New York, Chicago, and San Francisco, will help you to make comparison between both countries:

Statement showing the Rates of Weekly Wages Paid in France and the United States.

Occupations.	France.	New York.	Chicago.	San Francisco.
Bricklayers	$4 00	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	5 00	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	5 42	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Painters	4 90	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plumbers	5 50	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Slaters		10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
Blacksmiths	5 45	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	5 45	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	4 85	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	4 75	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Butchers	5 42	8 00 to 12 00	12 00 to 18 00	12 00 to 18 00
Cabinetmakers		9 00 to 13 00	7 00 to 15 00	13 50 to 18 00
Coopers	7 00	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths		12 00 to 15 00	15 00 to 21 00	13 50 to 18 00
Cutlers	4 63	10 00 to 13 00		11 50 to 16 50
Horseshoers	5 40	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Printers	4 71	12 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harness makers	5 00	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Tinsmiths	4 40	10 00 to 14 00	9 00 to 12 00	8 75 to 13 75
Tailors	5 10	10 00 to 18 00	6 00 to 18 00	15 00 to 21 00

The foregoing statement shows that wages in New York, Chicago, and San Francisco are, on an average, nearly three times as much as the wages throughout France.

It is to be regretted that the reports do not give any very extended information concerning the articles and prices of necessaries of life in the several districts of France. The following list, although very limited, may enable you to form an idea of the relative cost of food supplies in France and the United States:

Statement showing the Retail Prices of certain Articles of Food in the Cities of Bordeaux and La Rochelle, and in the Cities of New York, Chicago, and San Francisco.

Articles.	Bordeaux (Cents).	La Rochelle (Cents).	New York (Cents).	Chicago (Cents).	San Francisco (Cents).
Bread, per ℔.	3	3	4 to 4½	4 to 4½	*5 to 10
Beef, per ℔.	16 to 20	16 to 24	8 to 16	4 to 12½	8 to 20
Mutton, per ℔.	17 to 19	16 to 23	9 to 16	5 to 15	10 to 15
Veal, per ℔.	17 to 20	15 to 24	8 to 24	6 to 15	10 to 15
Pork, per ℔.	12 to 14	16	8 to 10	4 to 12	12 to 15
Flour, per ℔.	----------	4½ to 5	3½ to 4½	2½ to 4½	2½ to 3½
Coffee, per ℔.	----------	30	20 to 30	15 to 40	25 to 35
Butter, per ℔.	----------	30	25 to 32	16 to 40	20 to 35

*Per loaf.

When the workingmen of France are able to buy the foregoing articles, it may be assumed that they purchase the lowest priced. There is no doubt, therefore, that articles of food of the same qualities are very much cheaper in the United States than in France. Thus, while wages are very much higher in the United States than in France, the necessaries of life are cheaper with us.

The report of the Consulate-General at Paris gives the average daily wages throughout France as 45 cents, and the average annual income of the typical French family—father, mother, and five children, one of the latter old enough to work—as $180. The annual expenses of this family are: Bread, $66 40; meat, $17 60; vegetables and fruit, $11; wine and beer, $20 60; milk and eggs, $5 40; sugar and salt, $4 40; rent and taxes, $13 20; fire and lights, $7; clothing, $18; sundries, $10; total, $167 60.

SPAIN.

The reports herewith submitted from Spain are only four in number, viz.: from Barcelona, Cadiz, Malaga, and Santander; and, although not as minute or exhaustive as many of the reports from other countries, will be found interesting and instructive, dealing as they do with a class of people whose habits and customs are not as clearly understood in the United States as are like classes in other countries of Europe.

Rates of Wages.—The weekly rates of wages of agricultural laborers in Spain, as averaged from the submitted reports, are as follows:

Men, without board or lodging	$3 45
Women, without board or lodging	2 25
Women, house servants, per annum	40 00

The weekly wages paid the trades in Spain, and the wages paid similar trades in the United States, are as follows:

Occupations.	Spain.	New York.	Chicago.	San Francisco.
Bricklayers	$5 25	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	4 80	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters	4 88	9 00 to 12 00	7 50 to 12 00	12 00 to 24 00
Painters	4 80	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	7 20	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Blacksmiths	4 65	10 00 to 14 00	6 00 to 12 00	12 00 to 24 00
Bakers	5 40	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	3 60	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	3 90	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Cabinetmakers	4 20	9 00 to 13 00	7 00 to 15 00	13 50 to 18 00
Coopers	4 95	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Tinsmiths	3 90	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Tailors	3 90	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Laborers, porters, etc	3 00	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

It will be seen by the foregoing statement that the Spanish workingmen scarcely average one third the wages paid in New York, Chicago, and San Francisco, while what are called the necessaries of life with us are much cheaper in the United States than in Spain.

Habits of the Workingmen.—The Consul at Barcelona says:

The Catalonian laboring classes are certainly very laborious, and the most sober and frugal I have seen. During my four years' residence here I have never met an intoxicated person belonging to that class, yet wine is constantly drunk by the men, women, and children. Not being drunk for enjoyment, it is considered beneficial to health, and taken regularly, but sparingly, at every meal. The Catalonian people live mostly on greens, beans, potatoes, onions, garlic, dried codfish, and wine.

Andalusia.—The farm laborers of Andalusia, fed by their employers, are allowed, daily, three pounds of bread, some oil, and a little vinegar. A portion of the bread is set aside, with the oil and the vinegar, to form the two meals of the "gaspacho," served to the farm hands. This gaspacho consists of bread, soaked in water, to which the oil and vinegar are added. In Winter it is served hot, in Summer cold. Any addition to this fare must be supplied by the laborer himself.—[Report from Consul at Cadiz.

Malaga.—The laborer in the south of Spain is the most frugal of beings. He rarely, or never, eats meat. Indeed, it would be impossible for him to do so and live upon his earnings.—[From the report of the Consul at Malaga.

The Consul at Malaga says that while the rates of wages have increased from ten to fifteen per cent within the last five years, the cost of living has increased forty per cent within the same period.

The Consul at Santander notes only a slight increase in wages in five years; the increase in the cost of living has more than counterbalanced any increase in the wages.

RESUME.

Having given statements showing the rates of wages and the retail prices of the necessaries of life in the several countries, together with the wages and food prices in New York, Chicago, and San Francisco, I now submit two general statements, which will enable you, at a glance, to compare the wages and prices of food in the several countries with each other and all with the wages and prices in the United States. I also submit herewith two tables, showing the wages and food prices in the principal cities of Europe, as compared with the wages and food prices in New York, Chicago, and San Francisco.

Statement showing the Weekly Rates of Wages in the several Countries, compiled from the Consular Reports published herewith and compared with Rates prevailing in the United States.

Occupations.	Belgium	Denmark	France	Germany	Italy	Spain	United Kingdom. England.	United Kingdom. Ireland.	United Kingdom. Scotland.	United States. New York.	United States. Chicago.	United States. San Francisco.
Agricultural laborers:												
Men, without board or lodging			$3 15	$2 87	$3 50		$3 60	$3 40	$4 25			
Men, with board and lodging			1 36	1 48	1 80		2 60	1 30	1 50 to 2 40			
Women, without board or lodging			1 10	1 08	1 55		1 80	2 16	1 80 to 3 25			
Women, with board and lodging				75	60		1 15	75	60 to 1 00			
House-building trades:												
Bricklayers	$6 00		4 00	3 60	3 45	$5 12	8 12	7 58	9 63	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Carpenters and joiners	5 40	$4 25	5 42	4 00	4 18	4 88	8 25	7 33	8 12	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	5 40			3 65	3 95		7 25	7 95	8 40	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Masons	6 00	4 45	5 00	4 30	4 00	4 80	8 16	7 58	8 28	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Painters	4 20	4 15	4 90	3 92	4 60		7 25	7 54	8 16	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	5 40			3 80	4 35	7 20	8 10	7 68	10 13	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	6 00		5 50	3 60	3 90		7 75	8 46	7 13	12 00 to 18 00	12 00 to 20 00	15 00 to 24 00
Slaters				4 00	3 90		7 90		8 30	10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
General trades:												
Bakers	4 40	4 25	5 55	3 50	3 90	5 40	6 50		6 60	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Blacksmiths	4 40	3 90	5 45	3 55	3 94	4 65	8 12		7 04	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bookbinders		3 72	4 85	3 82	3 90	3 60	7 83		6 50	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Brass founders		4 20		3 20	5 49		7 40		6 90	10 00 to 14 00	8 00 to 15 00	
Butchers	4 50	4 50	5 42	3 85	4 20		7 23		4 75	8 00 to 12 00	12 00 to 18 00	12 00 to 18 00
Cabinetmakers	4 80		6 00	3 97	4 95	4 20	7 70		8 48	9 00 to 13 00	7 00 to 15 00	13 50 to 18 00
Coopers		4 10	7 00	3 30	4 35	4 95	7 30		6 10	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths		3 85		3 30	3 90		7 40		7 10	12 00 to 16 00	15 00 to 20 00	13 50 to 18 00
Cutlers		3 85	4 63	4 00	3 90		8 00		6 25	10 00 to 13 00	15 00 to 10 00	11 50 to 16 50
Engravers				4 00	4 00		9 72		8 75	15 00 to 25 00	9 00 to 30 00	18 00 to 30 00
Horseshoers		3 85	5 40	3 25	3 50		7 20		7 00	12 00 to 18 00	15 00 to 25 00	15 00 to 21 00
Millwrights		4 00		3 30	4 95		7 50		7 50	10 00 to 15 00	12 00 to 20 00	21 00 to 30 00
Printers		4 62	4 70	4 80	3 90		7 75		7 52	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harness makers	4 80	3 85	5 00	3 60	3 90		6 80		6 15	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers		4 85		3 30	3 90		7 30		6 33	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Shoemakers		3 30	4 75	3 12	4 32	3 90	7 35		7 35	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Tailors		4 10	5 10	3 58	4 30	3 90	5 00 to 7 30		7 00	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Tinsmiths	4 80	3 90	4 40	3 65	3 60	3 90	7 30		6 00	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Laborers, porters, etc.	3 00			2 92	2 60	3 00	5 00		4 50	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00
Railway employés:												
Engineers, passenger trains			11 33	8 35	9 50		9 12	9 00	8 75			
Firemen, passenger trains			6 25	3 30	4 50		6 00	4 50	4 96			
Brakemen, passenger trains			3 60	3 22			5 50	4 00	4 69			
Signalmen			5 85	3 52	4 00		5 60	5 00	5 12			
Switchmen			5 50	3 41	4 00		5 60	5 00	5 19			
Porters			5 00	2 60	3 40		4 50	4 00	4 44			
Laborers			3 35	3 10	3 30		4 50	4 00	4 27			

Statement showing the Weekly Rates of Wages in the Principal Cities of Europe, compiled from Consular Reports, and compared with Rates in New York, Chicago, and San Francisco.

Occupations.	Belgium.	France.	Germany.	Italy.	Spain.	Switzerland.	United Kingdom.	United States.		
	Brussels.	Bordeaux.	Dresden.	Rome.	Barcelona.	Geneva.	Liverpool.	New York.	Chicago.	San Francisco.
House building trades:										
Bricklayers	$6 00	$4 80		$3 00	$5 40	$4 80	$9 25	$12 to 15	$6 00 to 10 50	$24 00 to 30 00
Carpenters and joiners	5 40	5 00	$3 75	3 00	5 00	6 00	9 00	9 to 12	7 50 to 12 00	12 00 to 21 00
Gasfitters	5 40					4 60	7 80	10 to 14	10 00 to 12 00	15 00 to 21 00
Masons	6 00	5 40	3 75	3 00	6 00	4 80	8 70	12 to 18	12 00 to 15 00	18 00 to 24 00
Painters					7 00	4 60	8 50	10 to 16	6 00 to 12 00	15 00 to 21 00
Plasterers	5 40				7 00	4 60	9 72	10 to 15	9 00 to 15 00	24 00 to 30 00
Plumbers	6 00	6 00				4 60	9 00	12 to 18	12 [illegible] to 20 00	15 00 to 24 00
Slaters						4 60	9 72	10 to 15	12 00 to 18 00	15 00 to 18 00
General trades:										
Bakers	6 00	4 80	3 50		5 40	4 80		5 to 8	8 00 to 12 00	12 00 to 15 00
Blacksmiths	6 00	4 80	4 00	3 30	4 50	4 80	8 90	10 to 14	9 00 to 12 00	12 00 to 24 00
Bookbinders	6 00	4 80	2 00		3 60	4 60	8 00	12 to 18	9 00 to 20 00	15 00 to 24 00
Brass founders			3 00	4 75	6 00		7 20	10 to 14	8 00 to 15 00	
Butchers	6 00	6 00	4 00			4 60		8 to 12	12 00 to 18 00	12 00 to 18 00
Cabinetmakers	4 80				4 20	6 00	8 00	9 to 13	7 00 to 15 00	13 50 to 18 00
Coopers	6 00	8 00			5 50	4 60	8 75	12 to 16	6 00 to 15 00	13 50 to 18 00
Coppersmiths	6 00		4 75			4 60	8 90	12 to 16	15 00 to 20 00	13 50 to 18 00
Cutlers	5 50	4 20	4 00			4 60		10 to 13	15 00 to 10 00	11 50 to 16 50
Engravers	6 00					4 80		15 to 25	9 00 to 30 00	18 00 to 30 00
Horseshoers	6 00	4 80					8 50	12 to 18	15 00 to 25 00	15 00 to 21 00
Millwrights							7 70	10 to 15	12 00 to 20 00	21 00 to 30 00
Printers	6 00	6 00	3 00		4 80	4 60	10 50	8 to 18	12 00 to 18 00	15 00 to 22 50
Saddlers and harness makers	4 80	4 80				4 60	7 30	12 to 15	6 00 to 12 00	15 00 to 18 00
Sail makers	6 00							12 to 18	12 00 to 15 00	24 00 to 30 00
Shoemakers	6 00	4 20	2 00	3 60	3 60	4 60	8 75	12 to 18	9 00 to 18 00	12 00 to 18 00
Tailors	6 00	4 80	3 00	3 60	3 60	4 80		10 to 18	6 00 to 18 00	8 75 to 13 75
Tinsmiths	4 80	4 80	3 00		4 00	4 80	7 50	10 to 14	9 00 to 12 00	15 00 to 21 00
Laborers, porters, etc.	3 50		2 50			3 00	5 82	6 to 9	5 50 to 9 00	9 00 to 12 00

Statement showing the Retail Prices of the Necessaries of Life in the several Countries, compiled from Consular Reports, published herewith, and compared with Prices in New York, Chicago, and San Francisco.

Articles.	Belgium—In Cents.	France—In Cents.	Germany—In Cents.	Italy—In Cents.	Spain—In Cents.	Switzerland—In Cents.	United Kingdom. England.	United Kingdom. Ireland.	United Kingdom. Scotland.	United States. New York.	United States. Chicago.	United States. San Francisco.
Bread, per pound	4 to 5	3	3 to 7	6	6½ to 7½	4	3½ to 4½	4	4	4 to 4½	4 to 4½	*5 to 10
Flour, per pound		4	5½	10		7	3½ to 4½	4	4	3 to 4	2½ to 4½	2½ to 3
Beef—Roasting, per pound	20	22	22	30		30	22		22	12 to 16	8 to 12½	12 to 15
Soup, per pound	16	16	14	12	18	18	15		16	6 to 8	5 to 8	6 to 10
Rump steak, per pound	20	20	20	20		30	26½		26½	14 to 16	8 to 12½	15 to 20
Corned, per pound	16	16	13	12		18	18		20	8 to 12	4 to 7	10 to 15
Veal—Forequarter, per pound	16	16		15			18			8 to 10	6 to 10	8 to 12
Hindquarter, per pound	18	20	14	20	25	18	22½		25	10 to 12	10 to 12	12 to 18
Chops, per pound	20	22		22		20	27		30	20 to 24	12½ to 15	15
Pork—Fresh, per pound	16	14	17	13	24	18	16	10 to 12	13 to 16	8 to 10	4 to 5	15 to 18
Salted, per pound	16	14	17	18		20	15	10 to 12	13 to 16	8 to 10	6 to 12	10 to 15
Bacon, per pound	18	20	20	22			12 to 16			8 to 10	7 to 12	12 to 15
Ham, per pound	25	25	22	25	45	28	13 to 23		25	8 to 12	7 to 15	14 to 16
Shoulder, per pound	20	18	20	20			12			8 to 10	4 to 10	10 to 15
Sausage, per pound	20	16	19	20			18			8 to 10	6 to 10	15 to 20
Lard, per pound	20	20	21	22	21		15 to 18	12		10 to 12	6 to 10	12 to 15
Codfish, per pound				9	10		8		6	6 to 7	5 to 9	30
Butter, per pound	20 to 50	25	22	28	45	36	29 to 38	26½	32	25 to 30	16 to 40	15 to 25
Cheese, per pound	20 to 25		24	26	28	23	15 to 21		20	12 to 15	5 to 16	
Potatoes, per bushel	56	50	50	1 15	1 10	60	1 12 to 2 00	68	95	1 40 to 1 60	60 to 80	†1 00 to 1 50
Rice, per pound			9	6	7		3½ to 8		5	8 to 10	5 to 10	
Beans, per quart			10	13	12		9			7 to 10	5 to 9	
Milk, per quart			4	7		5	6 to 9		5	8 to 10	3 to 6	10
Eggs, per dozen	20 to 25	18	20	18	29 to 25	20	19 to 30	14	28	25 to 30	10 to 24	20 to 30
Oatmeal, per pound			8				3½ to 4½	3½	4	4 to 5	4 to 5	
Tea, per pound			75		70	50	43 to 88	80	70 to 88	50 to 60	25 to 1 00	70
Coffee, per pound	30 to 40	30	35	32	45	30	28 to 42		32 to 50	20 to 30	16 to 40	25 to 35
Sugar, per pound	15 to 20		11	8½	11	8	5½ to 9	8	10	8 to 10	7 to 10	8 to 10
Molasses, per gallon										60 to 70	40 to 80	1 00
Soap, per pound			10	4	10		5½ to 9			6 to 7	3 to 8	7
Starch, per pound			9	10	10		10 to 12		14	8 to 10	5 to 10	9
Coal, per ton			4 25	11 00	9 00		3 20 to 4 10		2 65	3 00 to 5 25	3 00 to 6 75	8 00 to 16 00

* Per Loaf. † Per 100 pounds.

Statement showing the Retail Prices of the Necessaries of Life in the Principal Cities of Europe, compiled from Consular Reports, and compared with same in New York, Chicago, and San Francisco.

Articles.	Belgium.	France.	Germany.	Italy.	Spain.	Switzerland.	United Kingdom.	United States.		
	Brussels—In Cents.	Bordeaux—In Cents.	Dresden—In Cents.	Rome—In Cents.	Barcelona—In Cents.	Geneva—In Cents.	Liverpool—In Cents.	New York—In Cents.	Chicago—In Cents.	San Francisco. In Cents.
Bread, per pound	4 to 5	3 to 4	7	6	—	4	3½ to 4	4 to 4½	4 to 4½	*5 to 10
Flour, per pound	—	—	6	10	6¼	7	3½ to 5	3 to 4	2½ to 4½	2½ to 3
Beef—Roasting, per pound	20	20	24	20	20	30	22	12 to 16	8 to 12½	12 to 15
Soup, per pound	16	16	18	12	15	18	16	6 to 8	5 to 8	6 to 10
Rump, per pound	18	18	19	15	18	25	18	14 to 16	8 to 12½	15 to 20
Corned, per pound	16	16	18	12	—	18	16	8 to 12	4 to 7	10 to 15
Veal—Forequarter, per pound	16	16	12	15	15	—	14	8 to 10	6 to 10	8 to 12
Hindquarter, per pound	18	20	18	20	18	18	20	10 to 12	10 to 12	12 to 18
Cutlets, per pound	20	22	18	22	22	20	20	20 to 24	12½ to 15	15
Mutton—Forequarter, per pound	16	16	12	15	12	—	14	9 to 10	5 to 12½	7 to 8
Hindquarter, per pound	18	20	18	18	15	18	20	12 to 14	5 to 12½	12 to 15
Chops, per pound	20	20	18	18	18	—	20	14 to 16	10 to 15	15 to 18
Pork—Fresh, per pound	16	12	18	15	20	18	16	8 to 10	4 to 8	15 to 18
Salted, per pound	16	14	18	18	20	20	16	8 to 10	6 to 12	10 to 15
Bacon, per pound	18	20	30	25	30	—	20	8 to 10	7 to 12	12 to 15
Ham, per pound	20	25	35	30	40	28	24	8 to 12	7 to 15	14 to 16
Shoulder, per pound	16	16	30	25	30	—	16	8 to 10	4 to 10	10 to 15
Sausage, per pound	18	16	20	20	—	—	20	8 to 10	6 to 10	15 to 20
Lard, per pound	20	—	20	25	19	—	16	10 to 12	6 to 10	12 to 15
Codfish, per pound	—	—	—	10	9	—	—	6 to 7	5 to 9	—
Butter, per pound	20 to 50	—	16	30	40	36	24 to 36	25 to 32	16 to 40	30
Cheese, per pound	20 to 25	—	33	28	25	23	12 to 20	12 to 15	5 to 16	15 to 25
Potatoes, per bushel	56	60	48	1 20	1 00	60	1 20 to 1 50	1 40 to 1 60	60 to 80	†1 00 to 1 50
Rice, per pound	—	—	10	5	6½	—	4 to 10	8 to 10	5 to 10	6
Beans, per quart	—	—	14	15	12	—	—	7 to 10	5 to 9	6
Milk, per quart	—	—	—	4	12	5	6 to 8	8 to 10	3 to 6	10
Eggs, per dozen	20 to 25	10 to 15	—	20	20	20	14 to 18	25 to 30	10 to 24	20 to 30
Oatmeal, per pound	—	—	—	—	—	—	3½ to 4	4 to 5	4 to 5	—
Tea, per pound	—	—	75	—	60	50	40 to 85	50 to 60	25 to 1 00	70
Coffee, per pound	30 to 40	—	36	40	40	30	24 to 40	20 to 30	15 to 40	25 to 35
Sugar, per pound	15 to 20	—	12	8	10	8	5 to 8	8 to 10	7 to 10	8 to 10
Molasses, per gallon	—	—	—	—	—	—	—	60 to 70	40 to 80	1 00
Soap, per pound	—	—	—	4	9	—	4 to 10	6 to 7	3 to 8	8
Starch, per pound	—	—	—	10	9	—	—	8 to 10	5 to 10	9
Coal, per ton	—	—	3 10	11 00	9 00	—	3 65 to 4 38	3 00 to 5 25	3 00 to 6 75	8 00 to 16 00

* Per loaf. † Per 100 pounds.

Here are a number of most important points, deducible from these reports, which should be kept prominently and permanently in sight, in order that the relative conditions of labor in Europe and in the United States may be thoroughly appreciated. Some of these points are as follows:

1. The rates of wages in the United States, roughly estimated, are more than twice those in Belgium; three times those in Denmark, France, and Germany; once and one half those in England and Scotland; and more than three times those in Italy and Spain.

2. The prices of necessaries of life are lower in the United States than in any of the foregoing countries; that is, the laboring people of Europe cannot purchase the necessaries of life, which are common to the American working people, as low as the same can be purchased in the United States; or, vice versa, if the working people of the United States lived on the same quality of food, or comparatively the same, and exercised the same frugality as the working people of Europe, they could live as cheaply as the working people of any country in Europe.

3. That while the present depression of trade in Europe has undoubtedly intensified the sufferings of its working classes, these reports but recite their normal condition; and while the present depression in the United States will eventually give way to better times, the working people of Europe have no "better days" to look forward to; as they are born to unremitting toil and scanty fare, so must they toil and mourn to the end, or emigrate.

4. That more misery is caused by strong drink in many countries in Europe than by dull times, and that more misery is caused by strikes than even strong drink, for the workingmen may reform and recover from strong drink, but no community of workingmen can ever recover from a "long strike."

5. That some of the happiest working people of Europe may be said to be those whose wages are least, while some of the unhappiest may be classed among those whose wages are the highest. The former results from temperance and frugality, the latter from strong drink and strikes.

6. That the ruling classes of Europe look forward at all times to the destruction of this republic at the hands of its workingmen; they see their own labor populations kept in order by force, and they cannot conceive how the working people of the United States can be a law unto themselves; hence all strikes and riots in this country are hailed in Europe as so many outbursts foreboding the final dissolution of the republic.

7. That the capitalists of Europe show more sympathy and kindly feeling toward their working people than the latter do toward the capitalists, and that all the bitterness and violence are on the side of the workingmen.

8. That the railroads of Europe, especially those of France and Germany, are so conducted as to make the interest of the employés as identical with the interests of the company as is possible—which will be seen by reading the very interesting reports from La Rochelle, Lyons, and Paris, where they refer to the subject, for France; and the reports from Bremen, Chemnitz, and Frankfort-on-the-Main, for Germany—the results of which wisdom on the part of the companies may be summed up in a few words: Good conduct and steadiness

insure permanent employment at good wages, with the further incentive to the employés that economy and care in fuel and of the property of the companies, brings the employés a good percentage, which increases their annual wages considerably.

The Consul at La Rochelle, noting the good conduct of the French railway employés, says: "Brotherhoods, or other such organizations, are unknown. No strikes occur, and the relations between the employés and the companies are entirely harmonious."

The Consul at Lyons, who writes at length on the railway systems of France, says: "On the whole, there appears to be no valid reason why our railway employés, of every rank and condition, should not, on comparing their pay and condition with those of their brethren in France, be every way contented and satisfied."

9. That the average American workman performs from one and a half to twice as much work, in a given time, as the average European workman. This is so important a point, in connection with our ability to compete with the cheap labor manufactures of Europe, and it seems, on first thought, so strange, that I will trouble you with somewhat lengthy quotations from the reports in support thereof:

Denmark.—Another evil is the diminished worth of wages, the descending quantity and quality of work now obtained by employers for wages higher than those paid ten years ago.—[From the report of the Consul at Copenhagen.

France.—At his work the French laborer or mechanic lacks the energy of the American of the same class, and the amount of work executed by him is much less in the same number of hours. The hours of labor are from eleven to twelve, but an average American workman will accomplish as much in nine hours.—[From the report of the Consul at Bordeaux.

Germany.—I am satisfied that an ordinary workingman in the United States will do as much again as will one in this district in the same time.—[From the report of the Consul at Chemnitz, Saxony.

An active American workman will do as much work in a given time, at any employment, as two or three German workmen.—[From the report of the Consul at Leipsic.

There can be no question that, speaking in general terms, the quality as well as the quantity of the work of the German artisans is inferior to that produced by the Americans. The workman here is inclined to be sluggish, and what he accomplishes is relatively small.—[From the report of the Consul at Sonneberg.

For the first time our manufactures are now assuming international proportions. At a time of universal depression we have met those nations which held a monopoly of the world's markets—met them in their strongholds, and established the fact that American manufactures are second to the manufactures of no other nation—and that, with a proper and patriotic understanding between capitalist and laborer, we can command a fair share of the buying world's patronage, and command that patronage with larger profits to the capitalist and higher wages to the laborer than can be made or paid in any other country.

There is something in the republic which gives an individuality to the people of the United States possessed by no other people to such a degree. Our inventive genius in mechanical appliances is original, and at least twenty-five years ahead of Europe. Our people accept innovation—are prepared for it by anticipation; Europeans do not. One workman in the United States, as will be seen from the foregoing extracts, does as much work as two workmen in most of the countries of Europe; even the immigrant from Europe attains this progressive spirit by a few years' association with American workmen. We have no oppressed and stupid peasantry, little more intelligent than the tools they handle. All are self-thinking, self-acting, and self-supporting.

Within the last fifteen years we have demonstrated our ability, by the brilliant development of our own resources, to exclude, by honest competition, foreign manufactures, to a large extent, from our shores. The question which now perëmptorily challenges all thinking minds is how to create a foreign demand for those manufactures which are left after supplying our home demands. We cannot stand still, for the momentum of increase will soon become so great that it will push us outward anyway; to push us safely and profitably is of so much importance as to almost overtop all other public questions of the hour. This question appeals equally to the selfishness and patriotism of all our citizens, but to the laborer it appeals with tenfold force, for without work he cannot live, and, unless we can extend the markets for our manufactures, he cannot expect steady work, and, unless our manufacturers can undersell foreign manufacturers, we cannot enlarge our foreign market.

The first great truth to be learned by the manufacturers and workingmen is that the days of sudden fortunes and double wages are gone. We must realize the fact that ocean steam communication has annihilated distance and brought the nations face to face. This drawing together of the nations means equalization in trade, profits, wages, etc., the advantage being with those who soonest accept the situation, and show the most sensible continuity in the new paths of success.

The Consul at Newcastle-upon-Tyne shows that that city is commercially nearer to New York than to London. If steam communication can thus bring one of the leading cities of a small island like England nearer to New York than to its own capital, it can work equal wonders with the leading seaport cities of all Europe in their commercial intercourse with the seaport cities of the United States. This is a question of great importance to both laborer and capitalist, for it must revolutionize all past theories of trade and commerce, by inaugurating international equalization.

In the near future, the workingman of New York cannot expect twice or thrice the wages of his fellow-worker in Europe, while all other things—food, rent, clothing, etc.—are on an equality; nor can the coal miner of Pennsylvania expect twice the wages of the Northumberland miner, while coal from the Northumberland mines can be landed in New York at less than the price of Pennsylvania coal.

Newcastle and New York.—During May, 1873, steamers were chartered from the Tyne to New York at $6 per ton, to take gas coals, which then cost $4 80 per ton, making the price of coals delivered in New York, including freight and insurance, $10 80 per ton.

Freights to New York have now reached the ridiculously low rate of 96 cents per ton, being 36 cents lower than to London. But Northumberland gas coal may now be delivered in New York (price, freight, and insurance) for $2 88 per ton. If coals were admitted free of duty, New York and other of our Atlantic cities might be furnished with fuel at a lower price than London; and the impetus which the abolition of this duty would probably give to our American wheat export trade is, at all events, worthy of careful consideration.—[From the report of Consul Jones.

In continuation of this question of international equalization, and what trade revolutions it can work when subsidized by steady and cheap labor, I shall quote from the report of the Consul at Dunferline an extract which, although only noting the building of an iron railway depot in Glasgow, is of great importance, and has astonished the iron workers and manufacturers of Scotland.

Scotch v. *Belgian Iron.*—While all the industries of the country are at present more or less depressed, I am not aware of any of them being more so than the iron trade. One of the reasons assigned is the damaging effects of foreign competition. Within the last year or two a large railway station has been erected at Glasgow, and it is a well known fact that all the iron required for its construction was brought from Belgium.

As Glasgow forms the center of the iron trade of Scotland, the circumstance above referred to is significant and startling.—[From a report of Mr. Walker, inspector of factories, on the iron trade of Scotland.

When steam has brought New York nearer to Newcastle than the latter is to London, and the steady, common sense, low priced labor of Belgium can compete with Scotland in the very center of her iron industry, and erect a railway station in Glasgow of iron brought from Belgium, even while the Scotch founders are on half time, there remains but one safe course for us to pursue, viz.: our American workingmen and their employers must go forward hand in hand, as in Belgium, if we would compete with the nations of Europe in the markets of the world.

Under no consideration must we have strikes; under no consideration must our factories lie idle. If our manufacturers cannot run their establishments profitably—and capital will no more remain permanently invested unprofitably than will labor work for nothing—and pay the prevailing wages, our working people must help them to make profit by consenting to a reduction of wages.

If our workingmen, native and naturalized, will only read these reports in that national spirit with which I have endeavored to point out some of the principal features therein, and drive from their midst communism, strikes, and drink—evil spirits born of oppression, and foreign to our country and institutions, fatal to them should these vicious principles ever attain national proportions—labor faithfully and intelligently, like freemen; live within their means, like frugal and sensible men; and choke down all demagogical attempt to divide the American people into hostile ranks as capitalists and laborers, there can be no reasonable limit set to the development of our manufactures and commerce; but if our trade centers are to be thrown into confusion, accumulated capital dissipated, and honest labor impoverished and demoralized by periodic strikes, we shall simply follow in the wake of the greatest commercial nation in the world, whose workingmen have blindly and madly ruined their bread source, and are now sorrowfully standing between their idle factories and the emigrant ships.

Let our workingmen read these reports and compare the fixed condition of the European labor populations, as graphically portrayed by our Consuls, with the free and independent position of our American workingmen, not as special depression has made them at present, but as they have been and as they will be again.

The workingman of Europe is born to labor through life; in labor must he continue to the end. There, indeed, are capital and labor severely and eternally divided, unless when some great upheaval in its madness pulls all things down to a common level. But in the United States the workingman of to-day may be the capitalist of to-morrow. Labor and capital are only divided by intelligence, industry, and pluck, and all honest, steady, sensible laborers work to become capitalists.

It is unfortunate that so many who have escaped from the bondage and travail of European labor, and become citizens of the United States, should so soon forget the wages, food, and condition from which they sought release through emigration, and show such small appreciation of their new and superior surroundings and condition as to seek, by strikes and organized violence—European methods of remedying European evils, and totally foreign to and subversive of republican institutions—to introduce strife where harmony and mutual reciprocity should alone prevail. It is equally deplorable, and more unaccountable, that so many native-born Americans should accept the teachings of the very worst school of Europe by countenancing or abetting strikes and communism.

Such things might be expected where the working people have no voice in the formation of the laws by which they are governed; but in a republic, where the people rule, resorts to violence to remedy existing evils only argue incapacity on the part of the violators of law.

But the great majority of American workingmen are intelligently true to the best interests of the republic, and the noisy and demoralizing few—for in a republic vice and demagogism, taking advantage of that freedom which was meant but for virtue alone, are always aggressive and violent—who keep irritating and goading the sensible majority, are public enemies, who eventually meet their merited punishment through the common sense of the people.

We are not a nation of capitalists and laborers; we are a nation of republican citizens. Let us, then, ignore these dividing lines, and, each accepting that position for which his capacity best fits him, work upward and onward in the scale of respectable citizenship, doing that which is best for all.

Let the workingman feel, as he should feel, that the man who employs him, who enables him to feed and clothe his wife and children, is his friend as well as his employer, and that all within and about the workshop are things to be protected, even with life if necessary, instead of being destroyed. Let the employer, on the other hand, as in Belgium and in Germany, look upon his workman as morally one of his family, to be treated with the dignity and sympathy which are his due, and in ten years we shall be known and felt in all the markets of the world, for under such circumstances neither cheap foreign labor nor the vast capital at its back could compete with the inventive genius, mechanical skill, and financial audacity of the workingmen and capitalists of the United States.

Weekly Wages Paid in Belgium and the United States.

Occupations.	Brussels.	New York.	Chicago.	San Francisco.
Building trades:				
Bricklayers	$6 00	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	6 00	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters and joiners	5 40	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	5 40	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	4 20	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	5 40	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	6 00	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Blacksmiths	4 40	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	4 40	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Cabinetmakers	4 80	9 00 to 13 00	9 00 to 15 00	13 50 to 18 00
Saddle and harness makers	4 80	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Tinsmiths	4 80	10 00 to 14 00	9 00 to 12 00	8 75 to 13 75
Laborers	3 00	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

It will be seen by the foregoing statement that the mechanics of Brussels do not receive anything like one half the wages received by the mechanics of New York, Chicago, and San Francisco.

To enable you to carry the comparison further, let me submit a statement showing the prices of the necessaries of life in both countries. I regret that the Belgian reports do not enable me to present as extended a list of articles as might be desirable, but the few articles given will enable you to apply the comparative rule to those not given.

Prices of the Necessaries of Life in Belgium and the United States.

Articles.	Brussels—In Cents.	New York—In Cents.	Chicago—In Cents.	San Francisco—In Cents.
Bread, per pound	4 to 5	4½	5	*5 to *10
Beef, per pound	16 to 20	8 to 16	4 to 12½	10 to 15
Veal, per pound	16 to 20	8 to 24	6 to 15	10 to 15
Mutton, per pound	16 to 20	9 to 16	5 to 15	6 to 10
Pork, per pound	16 to 20	8 to 10	4 to 12	10 to 15
Lard, per pound	20	10 to 12	6 to 10	12 to 15
Butter, per pound	20 to 50	25 to 32	16 to 40	30
Cheese, per pound	20 to 25	12 to 15	5 to 16	15 to 25
Coffee, per pound	30 to 40	20 to 30	15 to 40	25 to 35
Sugar, per pound	15 to 20	8 to 10	7 to 11	8 to 12

*Per loaf.

The foregoing statements show that while the Belgian workingman does not receive one half the wages of the American workingman, the former pays more for the necessaries of life than the latter.

According to the report from Brussels, it appears that while the rates of wages in the mechanical industries have fallen off 25 per cent during the last seven years, agricultural wages have been steadily on the increase. This has been due to the great development in manufactures, and to that desire, which seems to pervade all peoples, more or less, for the excitement of city life, which continually draws off agricultural labor.

ITALY.

In the United States, and in the principal countries of Europe also, the idea of labor proper is, to a great extent, associated in the common mind with the Scandinavians, the British, the Germans, and the French; the Italians and the Spaniards in that same mind being sentimentally connected with that labor which basks in the sun and resorts to agriculture only when forced by their necessities. The Italian in an especial manner is always associated with musical itineracy, and all that lazy life which goes to complete the round of strolling vagabondage.

The better portion of Italian emigrants—especially the agricultural laborers—have sought homes in South America, while a large number of that class which at once suggests the name and the calling of the padrone, have found a better field for their peculiar talents in the United States, thereby helping to confirm old errors in the public estimation.

That nothing can be more erroneous than the foregoing ideas in regard to the labor population of Italy, will be duly appreciated by the most casual perusal of the reports from that country, herewith submitted.

These reports bear ample evidence to the fact that the working classes of Italy are as industrious, as frugal, and as patient under privation as any peasant population in Europe, and that her artisans and mechanics stand on a par with their class elsewhere.

Rates of Wages.—The weekly rates of wages paid to agricultural laborers in Italy, as averaged from the consular reports herewith submitted, are as follows:

Men, without board or lodging	$3 50
Men, with board and lodging	1 80
Women, without board or lodging	1 55
Women, with board and lodging	65

The rates of wages paid to the trades in Italy, as compared with the rates paid to similar trades in the United States, are as follows:

Weekly Wages in Italy, New York, Chicago, and San Francisco.

Occupations.	Italy.	New York.	Chicago.	San Francisco.
Building trades:				
Bricklayers	$3 45	$12 00 to 15 00	$6 00 to 10 50	$24 00 to 30 00
Masons	4 00	12 00 to 18 00	12 00 to 15 00	18 00 to 24 00
Carpenters	4 18	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Gasfitters	3 95	10 00 to 14 00	10 00 to 12 00	15 00 to 21 00
Painters	4 60	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Plasterers	4 35	10 00 to 15 00	9 00 to 15 00	24 00 to 30 00
Plumbers	3 90	12 00 to 18 00	12 00 to 21 00	15 00 to 24 00
Slaters	3 90	10 00 to 15 00	12 00 to 18 00	15 00 to 18 00
Blacksmiths	3 94	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	3 90	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	3 90	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	4 32	8 00 to 12 00	9 00 to 18 00	12 00 to 18 00
Butchers	4 20	9 00 to 13 00	12 00 to 18 00	12 00 to 18 00
Cabinetmakers	4 95	12 00 to 16 00	7 00 to 15 00	13 50 to 18 00
Coopers	4 35	12 00 to 15 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths	3 90	10 00 to 13 00	15 00 to 21 00	13 50 to 18 00
Cutlers	3 90	15 00 to 25 00		11 50 to 16 50
Engravers	4 00	12 00 to 18 00	9 00 to 13 00	18 00 to 30 00
Horseshoers	3 50	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Millwrights	4 95	10 00 to 15 00	12 00 to 21 00	21 00 to 30 00
Printers	3 90	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harnessmakers	3 90	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers	3 90	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Tinsmiths	3 60	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Tailors	4 30	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Brassfounders	5 49	10 00 to 14 00	8 00 to 15 00	15 00 to 21 00
Laborers, porters, etc.	2 60	6 00 to 9 00	5 50 to 9 00	9 00 to 12 00

It will be seen by the foregoing table that the American tradesman receives more than three times as much wages as the Italian. It must not be inferred from this, however, that the Italian workingman cannot live comparatively well on his wages. The peculiar food on which he subsists—food which the American workman would not be satisfied with under any circumstances—can be purchased at such low rates as to enable him to do so. For instance, in Turin, according to the Consul's report, the laborer's daily expenses are, say 16 cents for food and 2 cents for lodging in a small room, where he has a family, "all stowed away in a single room."

In regard to what are considered by the American workingman as the necessaries of life, but which are considered luxuries by the Italian—luxuries never to be enjoyed save on great festivals, and then very sparingly—it will be seen by the following statement that they cost more in Italy than in the United States. It would, therefore, be impossible for the Italian laborer or mechanic to purchase such food out of his low wages.

Food Prices in Genoa, New York, Chicago, and San Francisco.

Articles.	Genoa—In Cents.	New York—In Cents.	Chicago—In Cents.	San Francisco—In Cents.
Flour, per pound	7	3 to 4	2½ to 4½	2½ to 3½
Beef, per pound	18	8 to 16	4 to 12½	8 to 20
Pork, per pound	20	8 to 12	4 to 12	12 to 15
Lard, per pound	28	10 to 12	6 to 10	10 to 15
Codfish, per pound	10	6 to 7	5 to 9	3 to 4
Butter, per pound	30	25 to 32	16 to 40	20 to 35
Cheese, per pound	28	12 to 15	5 to 16	12 to 20
Rice, per pound	7	8 to 10	5 to 10	5 to 7
Beans, per quart	8½	7 to 10	5 to 9	4 to 6½
Milk, per quart	6	8 to 10	3 to 6	10
Coal, per ton	$11 00	$5 25	$3 00 to 6 75	$8 00 to 16 00

The Habits of the Laborers.—The habits and manner of living of the Italian working people can be best shown by quoting from the consular reports:

Genoa.—The fare of the Italian laborer is usually very simple, consisting of bread, boiled chestnuts, mush, and ministrone, a substantial soup made of vegetables, olive oil, and macaroni. This, with an occasional bottle of ordinary wine, a relish of stock fish or cheese, and, at rare intervals, on great festivals and holidays, a dinner of fresh meat, constitutes the homely fare of the Italian peasant.—[From the report of Consul Spences.

Rome.—The ordinary laborer's fare is coarse bread and cheese and raw onions in the morning; at midday, a substantial soup of vegetables and macaroni, with fat pork or olive oil, or a dish of polenta (mush); in the evening, bread and cheese with onions or salad, as the case may be, sometimes varied with stock fish. On very rare occasions mutton or goat's meat and wine are indulged in.—[From the report of Consul-General McMillan.

Turin.—The agriculturist, both farmer and laborer, lives very economically, hardly knows what fresh meat is, except half a dozen times a year, on state and church festivals. Sometimes he eats a little sausage, but his daily food consists of corn meal mush, rice bread, soups of wheat flour paste, rice, and sometimes a little lard in the soup by way of luxury, cheese, greens, and chestnuts in their season.—[From the report of Consul Noble.

Messina.—The laboring classes are frugal and industrious. Contented with little and living on what our workmen would despise, there is very little destitution among them.—[From the report of Consul Owen.

The Consul at Messina says that the condition of the working classes has very much improved under the present Government. The opening of public schools and the law which withholds the discharge of a soldier until he can read and write have been productive of good results.

NETHERLANDS.

The two reports herewith from the Netherlands, although not as full and minute as might be desired, are sufficiently so to enable you to form a fair idea of the present condition of labor in that country.

According to the report from Amsterdam, agricultural laborers are paid from $50 to $60, with board and lodging, and usually two suits of common clothes, per annum. Hired by the day they receive from 40 to 60 cents, without either board or lodging. The Consul at Rotterdam says that the wages of farm hands in his district average about 40 cents per day, without food or lodging.

An average from both reports shows the weekly wages of mechanics and laborers to be as follows: Bricklayers, masons, carpenters and joiners, painters, and plasterers, $3 60 to $6; shoemakers, $3 60 to $6 60; tailors, $3 60 to $6 80; laborers, porters, etc., $2 40 to $3 60.

Low as are the foregoing rates of wages, the Consul at Amsterdam says that they are from 25 to 35 per cent higher than they were five years ago, but that the cost of living has increased in even greater proportion, so that, with all his patient frugality and practical economy, the Dutch workingman has all he can do to maintain himself and family.

In regard to the food of the Dutch workingmen, the Consul at Rotterdam says: "Meat, excepting sausage and chipped beef, is regarded by the mechanic and laboring man as a luxury, and is rarely indulged in. Bread, rice, fish, potatoes, and other vegetables, constitute the staple articles of food for the laboring classes of the Netherlands."

DENMARK.

According to the report of the Consul at Copenhagen, the present rates of wages throughout Denmark are from ten to fifteen per cent less than they were in 1872, while the cost of living is somewhat higher. Agricultural laborers are paid as follows, computing the daily wages and averaging Summer and Winter:

Men, without board or lodging, per week	$1 85
Men, with board and lodging, per week	1 00
Women, without board or lodging, per week	1 25
Women, with board and lodging, per week	72
Women house servants, per year	19 00

Small as are these rates, they must be the maximum, for the Consul says that, "as a general rule, farm hands are employed at from $2 16 to $2 70 per month, without board and lodging." This would give an average of only about $31 per annum as the wages of agricultural laborers.

The wages paid to the several trades in Copenhagen, and the rates paid to similar trades in New York, Chicago, and San Francisco, will be seen by the following statement:

Weekly Wages in Copenhagen, New York, Chicago, and San Francisco.

Occupations.	Copenhagen.	New York.	Chicago.	San Francisco.
Masons	$4 45	$12 00 to $18 00	$12 00 to $15 00	$24 00 to $30 00
Carpenters and joiners	4 25	9 00 to 12 00	7 50 to 12 00	12 00 to 21 00
Painters	4 15	10 00 to 16 00	6 00 to 12 00	15 00 to 21 00
Blacksmiths	3 90	10 00 to 14 00	9 00 to 12 00	12 00 to 24 00
Bakers	4 25	5 00 to 8 00	8 00 to 12 00	12 00 to 15 00
Bookbinders	3 72	12 00 to 18 00	9 00 to 20 00	15 00 to 24 00
Shoemakers	3 30	12 00 to 18 00	9 00 to 18 00	12 00 to 18 00
Butchers	4 50	8 00 to 12 00	12 00 to 18 00	12 00 to 18 00
Coopers	4 10	12 00 to 16 00	6 00 to 15 00	13 50 to 18 00
Coppersmiths	3 85	12 00 to 15 00	15 00 to 21 00	13 50 to 18 00
Cutlers	3 85	10 00 to 13 00	----------	11 50 to 16 50
Horseshoers	3 85	12 00 to 18 00	15 00 to 21 00	15 00 to 21 00
Millwrights	4 00	10 00 to 15 00	12 00 to 21 00	21 00 to 30 00
Printers	4 62	8 00 to 18 00	12 00 to 18 00	15 00 to 22 50
Saddlers and harnessmakers	3 85	12 00 to 15 00	6 00 to 12 00	15 00 to 18 00
Sailmakers	4 85	12 00 to 18 00	12 00 to 15 00	24 00 to 30 00
Tinsmiths	3 90	10 00 to 14 00	9 00 to 12 00	15 00 to 21 00
Tailors	4 10	10 00 to 18 00	6 00 to 18 00	8 75 to 13 75
Brassfounders	4 20	10 00 to 14 00	8 00 to 15 00	15 00 to 21 00

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